ProtoTRAK® SMX
K2, K3, K4 & Retrofit

Safety, Installation, Maintenance, Service & Parts List Manual

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1.0 Safety

The safe operation of the TRAK K Mills depends on its proper use and the precautions taken by each operator.

- Read and study this manual and the ProtoTRAK SMX Programming, Operating, and Care Manual. Be certain every operator understands the operation and safety requirements of this machine *before* its use.
- Always wear safety glasses and safety shoes.
- Always stop the spindle and check to ensure the CNC control is in the stop mode before changing or adjusting the tool or workpiece.
- Never wear gloves, rings, watches, long sleeves, neckties, jewelry, or other loose items when operating or around the machine.
- Use adequate point of operation safeguarding. It is the responsibility of the employer to provide and ensure point of operation safeguarding per OSHA 1910.212 - Milling Machine.

1.1 Safety Publications

Refer to and study the following publications for assistance in enhancing the safe use of this machine.

Safety Requirements for Manual Milling, Drilling and Boring Machines with or without Automatic Control (ANSI B11.8-2001). Available from The American National Standards Institute, 1819 L Street N.W., Washington D.C. 20036

Concepts And Techniques Of Machine Safeguarding (OSHA Publication Number 3067). Available from The Publication Office - O.S.H.A., U.S. Department of Labor, 200 Constitution Avenue, NW, Washington, DC 0210.

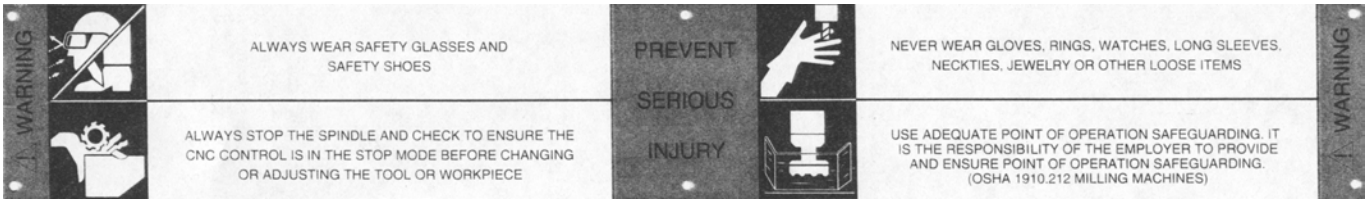
1.2 Danger, Warning, Caution, and Note Labels & Notices As Used In This Manual

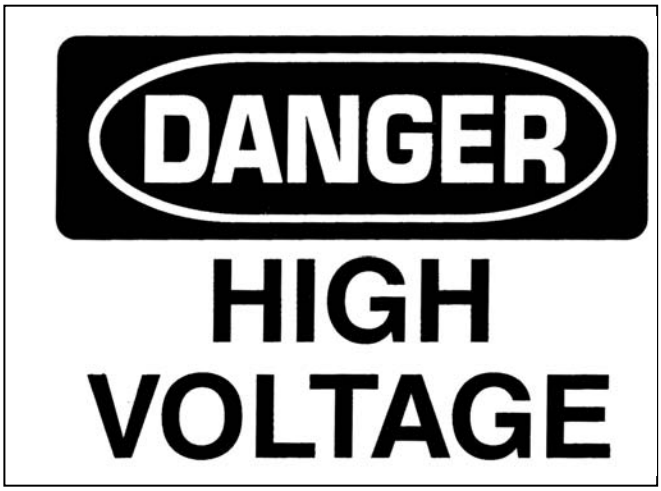
DANGER - Immediate hazards that **will** result in severe personal injury or death. Danger labels on the machine are red in color.

WARNING - Hazards or unsafe practices which *could* result in severe personal injury and/or damage to the equipment. Warning labels on the machine are orange in color.

CAUTION - Hazards or unsafe practices, which *could* result in minor personal injury or equipment/product damage. Caution labels on the machine are yellow in color.

NOTE - Call attention to specific issues requiring special attention or understanding.


WARNING
ALWAYS WEAR SAFETY GLASSES AND SAFETY SHOES
ALWAYS STOP THE SPINDLE AND CHECK TO ENSURE THE CNC CONTROL IS IN THE STOP MODE BEFORE CHANGING OR ADJUSTING THE TOOL OR WORKPIECE
PREVENT SERIOUS INJURY
NEVER WEAR GLOVES, RINGS, WATCHES, LONG SLEEVES, NECKTIES, JEWELRY OR OTHER LOOSE ITEMS
USE ADEQUATE POINT OF OPERATION SAFEGUARDING. IT IS THE RESPONSIBILITY OF THE EMPLOYER TO PROVIDE AND ENSURE POINT OF OPERATION SAFEGUARDING. (OSHA 1910.212 MILLING MACHINES)
WARNING

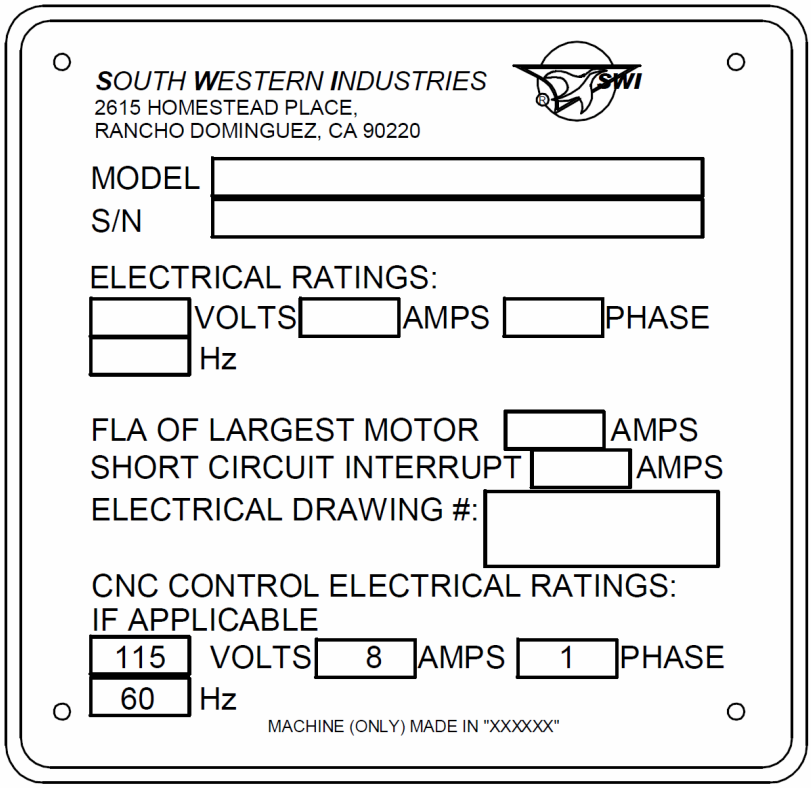


NOTICE: The manufacture is not liable (responsible) for any damages or injury of any kind to persons or property caused by or resulting from the improper or unauthorized use, operation, maintenance, alteration, modification, change in configuration of this machine or any of its component parts, or the use of this unit with any third party accessories or parts.

.i00775

Safety & Information Labels Used On The TRAK K Milling Machines

It is forbidden by OSHA regulations and by law to deface, destroy or remove any of these labels



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Safety & Information Labels Used On The TRAK K2, K3 & K4 Milling Machines

It is forbidden by OSHA regulations and by law to deface, destroy or remove any of these labels

Power Requirements at 220 and 440 Volts, 3-phase 60 Hz				
	SMX K2 / K3		**SMX K4**	
	Vari-speed Head	Spindle Control	Vari-speed Head	Spindle Control
Overload Setting 220 V	8.5 A	11 A	14 A	17.5 A
Overload Setting 440 V	4.25 A	n/a	7 A	n/a
FLA of Largest Motor at 220 V	8.5 A	11 A	14 A	17.5 A
FLA of Largest Motor at 440 V	4.25 A	n/a	7 A	n/a
FLA of Machine at 220 V	8.5 A	11 A	14 A	17.5 A
FLA of Machine at 440 V	4.25 A	n/a	7 A	n/a

1.3 Safety Precautions

1. Do not operate this machine before the **TRAK K Mill Installation, Maintenance, Service and Parts List Manual**, and **ProtoTRAK SMX Programming, Operating & Care Manual** have been studied and understood.

2. Do not run this machine without knowing the function of every control key, button, knob, or handle. Ask your supervisor or a qualified instructor for help when needed.

3. Protect your eyes. Wear approved safety glasses (with side shields) at all times.

4. Don't get caught in moving parts. Before operating this machine remove all jewelry including watches and rings, neckties, and any loose-fitting clothing.

5. Keep your hair away from moving parts. Wear adequate safety headgear.

6. Protect your feet. Wear safety shoes with oil-resistant, anti-skid soles, and steel toes.

7. Take off gloves before you start the machine. Gloves are easily caught in moving parts.

8. Remove all tools (wrenches, chuck keys, etc.) from the machine before you start. Loose items can become dangerous flying projectiles.

9. Never operate a milling machine after consuming alcoholic beverages, or taking strong medication, or while using non-prescription drugs.

10. Protect your hands. Stop the machine spindle and ensure that the CNC control is in the stop mode:
    - Before changing tools
    - Before changing parts
    - Before you clear away the chips, oil or coolant. Always use a chip scraper or brush
    - Before you make an adjustment to the part, fixture, coolant nozzle or take measurements
    - Before you open safeguards (protective shields, etc.). Never reach for the part, tool, or fixture around a safeguard.

11. Protect your eyes and the machine as well. Don't use compressed air to remove the chips or clean the machine.

12. Disconnect power to the machine before you change belts, pulley, and gears.

13. Keep work areas well lighted. Ask for additional light if needed.

14. Do not lean on the machine while it is running.

15. Prevent slippage. Keep the work area dry and clean. Remove the chips, oil, coolant and obstacles of any kind around the machine.
16. Avoid getting pinched in places where the table, saddle or spindle head create "pinch points" while in motion.

17. Securely clamp and properly locate the workpiece in the vise, on the table, or in the fixture. Use stop blocks to prevent objects from flying loose. Use proper holding clamping attachments and position them clear of the tool path.

18. Use correct cutting parameters (speed, feed, depth, and width of cut) in order to prevent tool breakage.

19. Use proper cutting tools for the job. Pay attention to the rotation of the spindle: Left hand tool for counterclockwise rotation of spindle, and right hand tool for clockwise rotation of spindle.

20. After an emergency stop, always turn the FORWARD/REVERSE switch to "Off" (STOP) before releasing or resetting the E-Stop.

21. Prevent damage to the workpiece or the cutting tool. Never start the machine (including the rotation of the spindle) if the tool is in contact with the part.

22. Check the direction (+ or -) of movement of the table, saddle, and quill when using the jog or power feed or ram out.

23. Don't use dull or damaged cutting tools. They break easily and become airborne. Inspect the sharpness of the edges, and the integrity of cutting tools and their holders. Use proper length for the tool.

24. Large overhang on cutting tools when not required result in accidents and damaged parts.

25. Handwheels must have the crank folded inside when using CNC programmed machining or rapid feeds, power feed or jog.

26. Prevent fires. When machining certain materials (magnesium, etc.) the chips and dust are highly flammable. Obtain special instruction from you supervisor before machining these materials. Keep flammable materials and fluids away from the machine and hot, flying chips.

27. Changing the speed of rotation of the spindle must be done while the rotation is on. It is recommended to stop and start the spindle at a low rate of speed.

28. For non-spindle control machines - interlocked table guards. Interlocked table guards may be purchased from Southwestern Industries, Inc. if deemed necessary by the user.

2.0 Installation

Read and understand this entire installation section before beginning the installation procedure.

2.1 Floor Plan, Layout & Space Requirements – K2, K3 & K4

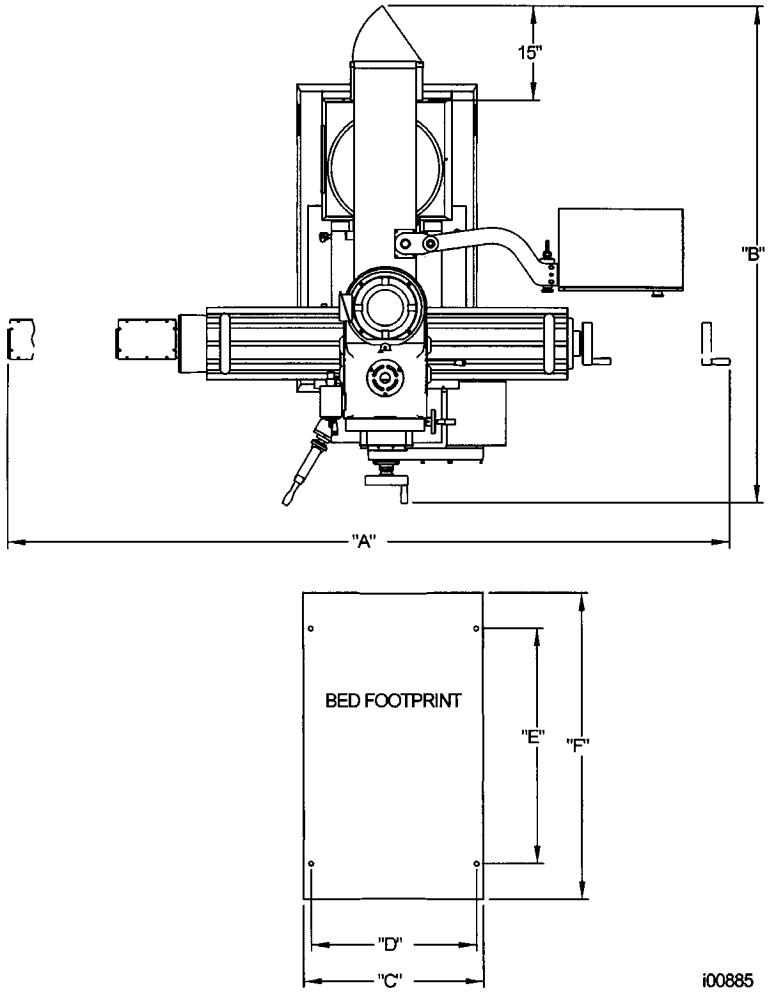


Figure 1 – Machine Footprints

	K2	K3	K4
Weight (approximate) net	2200 lbs	2800 lbs	3600 lbs
Weight (approximate) shipping	2500 lbs	3100 lbs	3900 lbs
Pallet Size	6' x 6'	6' x 6'	6' x 6'
A Overall width	101"	103"	103"
B Overall length	66"	70"	72.5"
C Base width	24.2"	24.2"	24"
D Width between leveling screws	21.9"	21.9"	22.8"
E Distance between leveling screws	29.1"	29.7"	33.1"
F Base length	37.4"	38.8"	42.5"

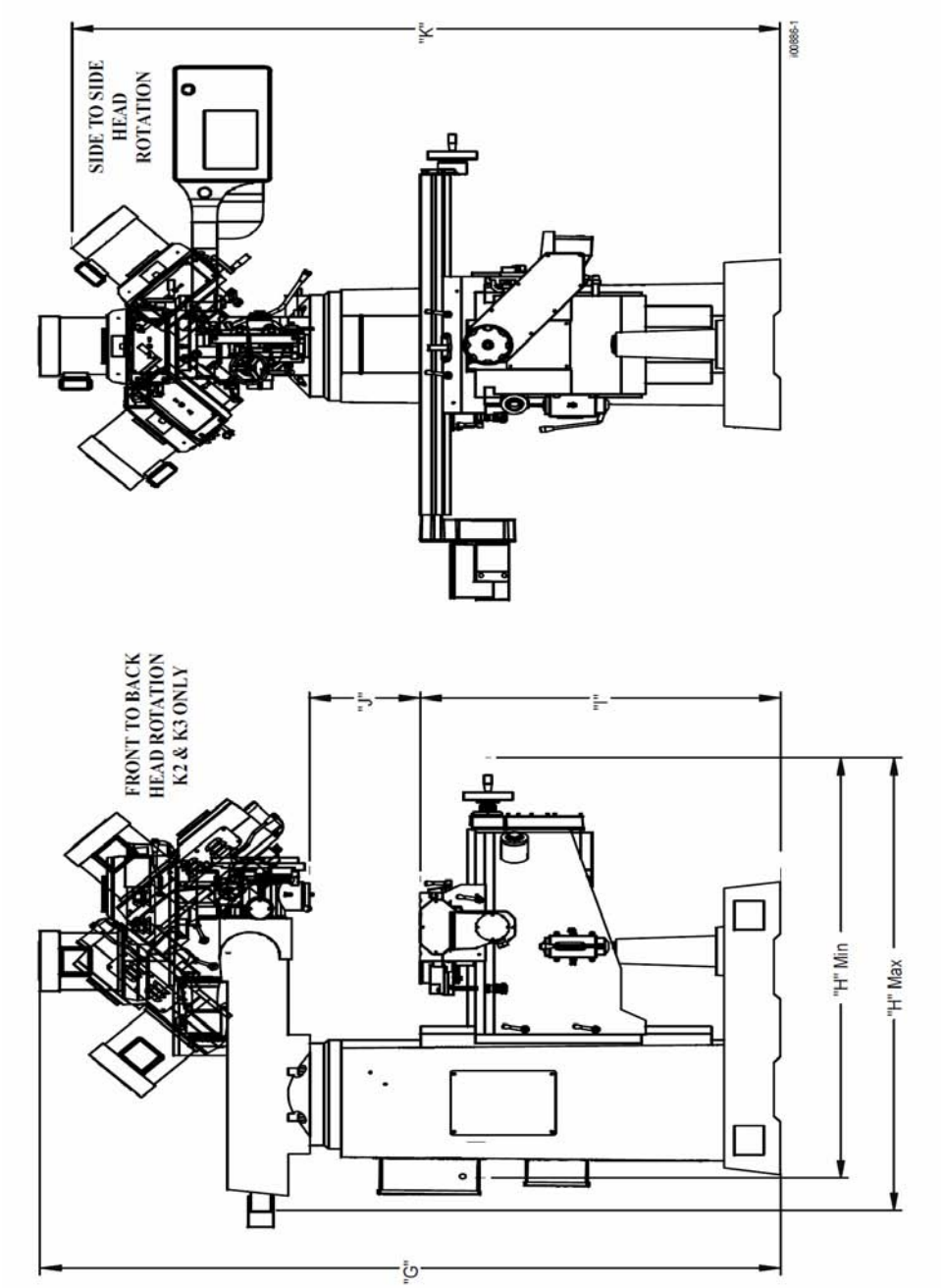


Figure 2 - Overall Dimensions

	K2	K3	K4
Table Size	9” x 49”	10” x 50”	10” x 50”
T-Slots (number x width)	3” x 5/8”	3” x 5/8”	3” x 5/8”
Dimension G	86”	87”	92”
Dimension G Min	65”	65”	73”
Dimension H Min	56”	64”	64”
Dimension H Max	67”	78”	78”
Dimension I Min	36”	38”	36”
Dimension I Max	49”	49’	54.5
Dimension J Max	18”	17”	23”
Dimension K	69”	69”	77”

2.2 Uncrating

Carefully remove the wood crate and protective packaging, paying attention not to scratch, damage, or mar any parts of the machine.

Remove the cardboard boxes with the PENDANT DISPLAY (handle carefully) and the box containing the TOOL BOX. The leveling pads and screws for the machine can be found in the toolbox. The Y way covers are shipped in a separate tube.

Loosen and remove 4 screws and nuts holding the machine to the wood pallet.

ATTENTION!
Immediately report, in writing, any damages observed at this time that can be attributed to the transportation or improper handling/moving of the machine.

2.3 Shortages: Inventory Checklist

_____ Machine (check model and serial number)

_____ Manual drawbar with washer

_____ Leveling pads (FC114), screws (FC112) and leveling nuts (FC113) (4 each)

_____ Pendant Display with four 1/4-20 screws for mounting

_____ Pendant Arm assembled to the column

_____ Toolbox with various tools

_____ ProtoTRAK SMX Safety, Operation & Programming Manual (P/N 24493)

_____ TRAK K2, K3, K4 & Retrofit Safety, Installation, Maintenance, Service & Parts List Manual (P/N 24319)

_____ Way covers K2 – front of saddle - 20875

_____ Way covers K3 & K4 – front of saddle - 20872

_____ Way covers K2 – rear of saddle - 20874

_____ Way covers K3 & K4 – rear of saddle - 20871

In case of shortages, contact the representative from whom you purchased the machine.

2.4 Installation Instructions & Checklist

Installer: Use this checklist to assure a complete set-up of the K2, K3, K4 or SMX 2 or 3-axis retrofit.

☐	1.	Shut off power to the machine.
☐	2.	Visually inspect the 220 or 440V wiring going into the electrical panel. Visually verify the wiring is correct per our wiring diagram. Make sure a strain relief is being used where the wiring enters the cabinet. Have the customer repair any wiring discrepancies. **NOTE: Machine with Spindle Control Option is only available in 220V configuration.**
☐	3.	Clean the machine if needed and remove any remaining grease.
☐	4.	Unlock the table, saddle, and knee gib locks.
☐	5.	Mount the pendant to the pendant arm using (4) 1/4-20 x 3/4" socket head cap screws.
☐	6.	Make and check all the proper electrical connections from the pendant to the electric box. See the pendant and electric box wiring diagrams.
☐	7.	On retrofits, place the nameplate serial # plate (21934) on the pendant arm. This serial # plate is the main system # for that machine. Place the serial # plate using 2 drive screws to the front of the pendant arm near the pivot point of the arm. Use a #36 drill bit for drive screws. See figure 57.
☐	8.	If applicable, load TRAK sensors.
☐	9.	On retrofits and TRAK knee mills make sure to plug in the machine ID key on the top corner of pendant before powering up the pendant. Failure to do so may cause an improper configuration file. If this happens, go to service code 313 and load the defaults. Loading defaults will erase any calibration factors that have been done. See pendant connection – Figure 13.
☐	10.	Turn on the power to the machine and to the pendant.
☐	11.	Loadmaster and slave software from software upgrade disk. The pendant may or may not have the latest software loaded. (Retrofits only.)
☐	12.	Lubricate all the way surfaces and the ball screws.
☐	13.	Jog the table and saddle back and forth until the way surfaces are well lubricated. Oil should be visible on all the way surfaces.
☐	14.	Check the level of the machine. The machine should be level to within 0.0005" front to back and 0.0005" side to side. Even though it is the responsibility of the customer, make any adjustments if necessary.
☐	15.	Check to make sure that the E-Stop button is functioning correctly. N/A to retrofits for spindle.
☐	16.	Perform Service Code 12, Feed Forward Constant.
☐	17.	Perform Service Code 123 to calibrate the X and Y-axis using a 150mm standard.
☐	18.	Perform Service Code 11 to automatically calculate the backlash for the X and Y-axis of dual feedback machines (i.e. TRAK sensor or glass scale with a motor encoder).
☐	19.	Perform Service Code 127 and 128 to manually calculate the backlash for the X and Y-axis of single feedback machines (i.e. motor encoder only).
☐	20.	Check for positional accuracy and repeatability on the X and Y-axis using programs XREPEAT 2 AXIS.PT4 and YREPEAT 2 AXIS.PT4 respectively. Positioning and repeatability values should be less than or = to 0.0005". Programs can be found on flash drive under the PT4 folder followed by the SWI TEST PROGRAMS folder.
☐	21.	For 2 axis machines - perform Service Code 123 and press QUILL softkey to calibrate the Z-axis quill using a 75mm standard.
☐	22.	For 3 axis machines - perform Service Code 123 and press Z softkey to calibrate the Z-axis ball screw encoder using a 75mm standard.
☐	23.	Perform Service Code 100 in both directions for the X, Y, and Z-axis to verify that the feed rate shown on the display is at least 120 ipm.
☐	24.	Run the spindle at various speeds in both high and low gear for 15 minutes. Verify head shifts from high to low gear smoothly. Test quill feed and spindle brake. N/A to retrofits.
☐	25.	Install the Y-axis front and rear way covers.
☐	26.	3 axis machines only - If machine has an auxiliary function option, then use accessory key on

	pendant and make sure the coolant pump or solenoid for the mister fires. The accessory key should be in the ON position to test coolant pump or solenoid. The control should be in DRO mode. Make sure air is hooked up to the machine during the test. If the machine has a separate coolant pump switch mounted on the pendant arm then turn this on and off to test.
☐	27. If the machine has a power drawbar option, check to make sure that the tools load and unload properly. N/A to retrofits.
☐	28. Wipe down the machine prior to leaving.

2.5 Machine Specifications

	K2	K3	K4
Movement and ranges (X, Y, Z axis)	33" x 12" x 16"	32" x 16" x 16"	32" x 16 ½" x 16.5"
Quill Travel (maximum)	5"	5"	5"
Quill Diameter	86 mm	86 mm	100 mm
Spindle Taper	R8	R8	# 40 taper
Speed Range	60-4200 RPM	60-4200 RPM	70-3950 RPM
Optional Spindle Control Speed Range	Low: 40 – 600	Low: 40 – 600	Low: 40 – 600
	High: 300 – 5000	High: 300 – 5000	High: 300 – 5000
Spindle to Column	8" to 20"	8" to 32"	7" to 31"
Quill Feeds Per Revolution of Spindle (Not applicable on three axis)	.0015/.003/.006"	.0015/.003/.006"	.0015/.003/.006"
Head Tilt	+/- 90°	+/- 90°	+/- 90°
Head Swivel	+/- 45°	+/- 45°	N/A
Spindle Motor Power	3 HP	3 HP	5 HP
Voltage	220/440 V	220/440 V	220/440 V
Machine with Optional Speed Control	220 V	220 V	220 V
Phase/Cycle	3 phase/60 Hz	3 phase/60 Hz	3 phase/60 Hz
Current- Non Spindle Control	8.5/4.3 amps	8.5/4.3 amps	14/7 amps
Current – Spindle Control	11 amps	11 amps	17.5 amps
Maximum Weight of Workpiece	750 lbs	850 lbs	850 lbs

2.6 Maximum Work Capacities

	K2/K3	K4
Drilling Mild Steel (2-axis manual feed)	1 ¼"	1 ½"
Tapping Mild Steel	1"	1"
Milling (metal removal rate/mild steel)	1 ½ $inch^3$/min	2 $inch^3$/min
Drilling (3-axis systems)	½"	½"

Maximum work capacities are dependent on a lot of variables that cannot be controlled by the machine manufacturer. Each one of the following will have an impact on the above numbers: speeds, feeds, cutter, cutter sharpness, material, setup, coolant and machine adjustments. The numbers above assume all conditions are optimal and may be higher or lower depending on material composition.

2.7 ProtoTRAK SMX Control Hardware

- 2 or 3-axis CNC, 3-axis DRO
- 400 PC-based processor
- 256 MB of RAM
- D.C. Servo Motors rated at 280 in-oz continuous torque for X, Y and Z-axes
- Precision ground ballscrews in the table and saddle to ensure smooth accurate contours without backlash
- Feedrate override of programmed feedrate and rapid
- Polycarbonate sealed membrane and gasket sealed control enclosure to lock out contamination
- 10 ½" color LCD for clear presentation of prompts, status information and part graphics
- Modular design simplifies service and maximizes uptime
- 256 MB flash drive
- Single floppy disk drive for additional part program storage
- Optional auxiliary function box for control of coolant pump or spray mist coolant, spindle off and a programmable rotary table or indexer – 3 axis machines only

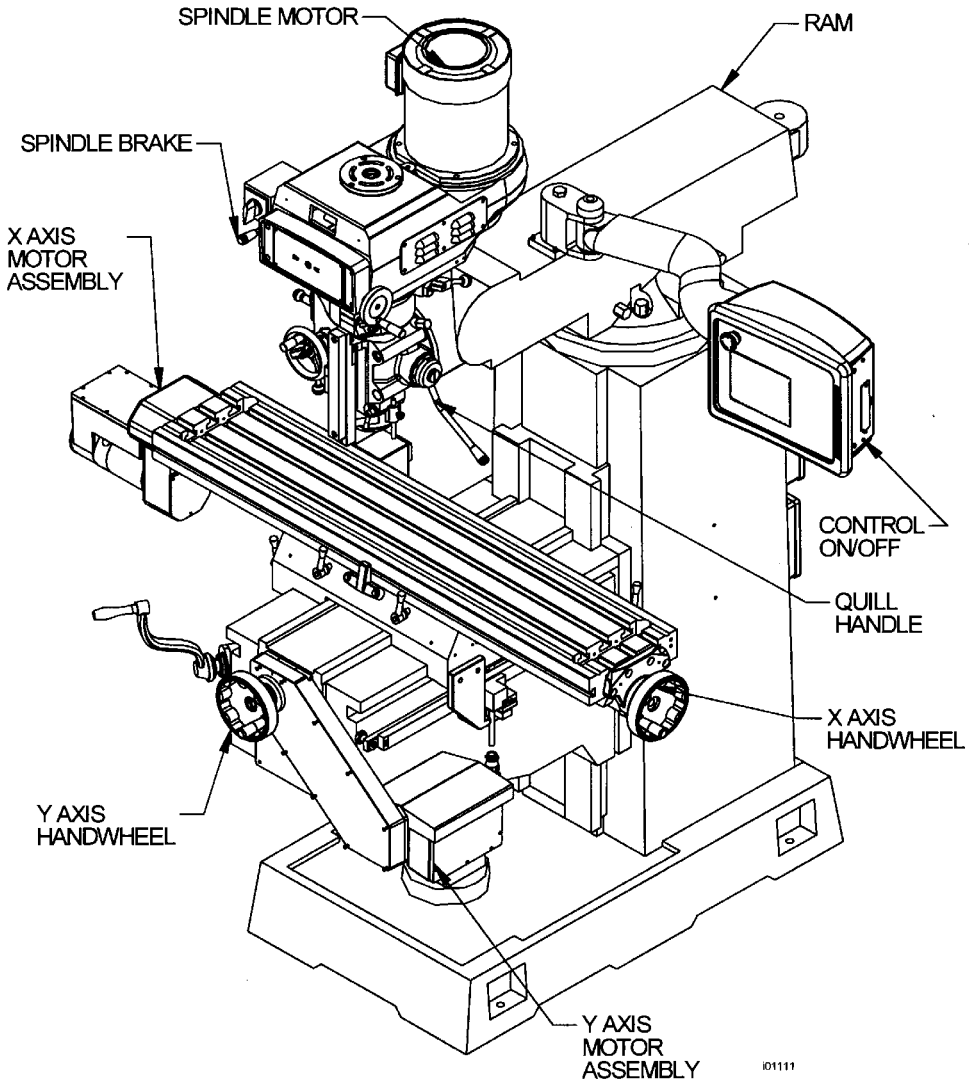


Figure 3
Knee Mill Component Identification

Item	Part Number				Description
	SMX K2 + K3	**SMX K2 + K3** Spindle Control	**SMX K4**	**SMX K4** Spindle Control	
1	20819	24162	20820	24163	Spindle Motor
2	24000-1				SMX Pendant
3	15616				Y-Axis Handwheel (Saddle)
4	15616				X-Axis Handwheel (Table)
5	20296				X, Y or Z Motor

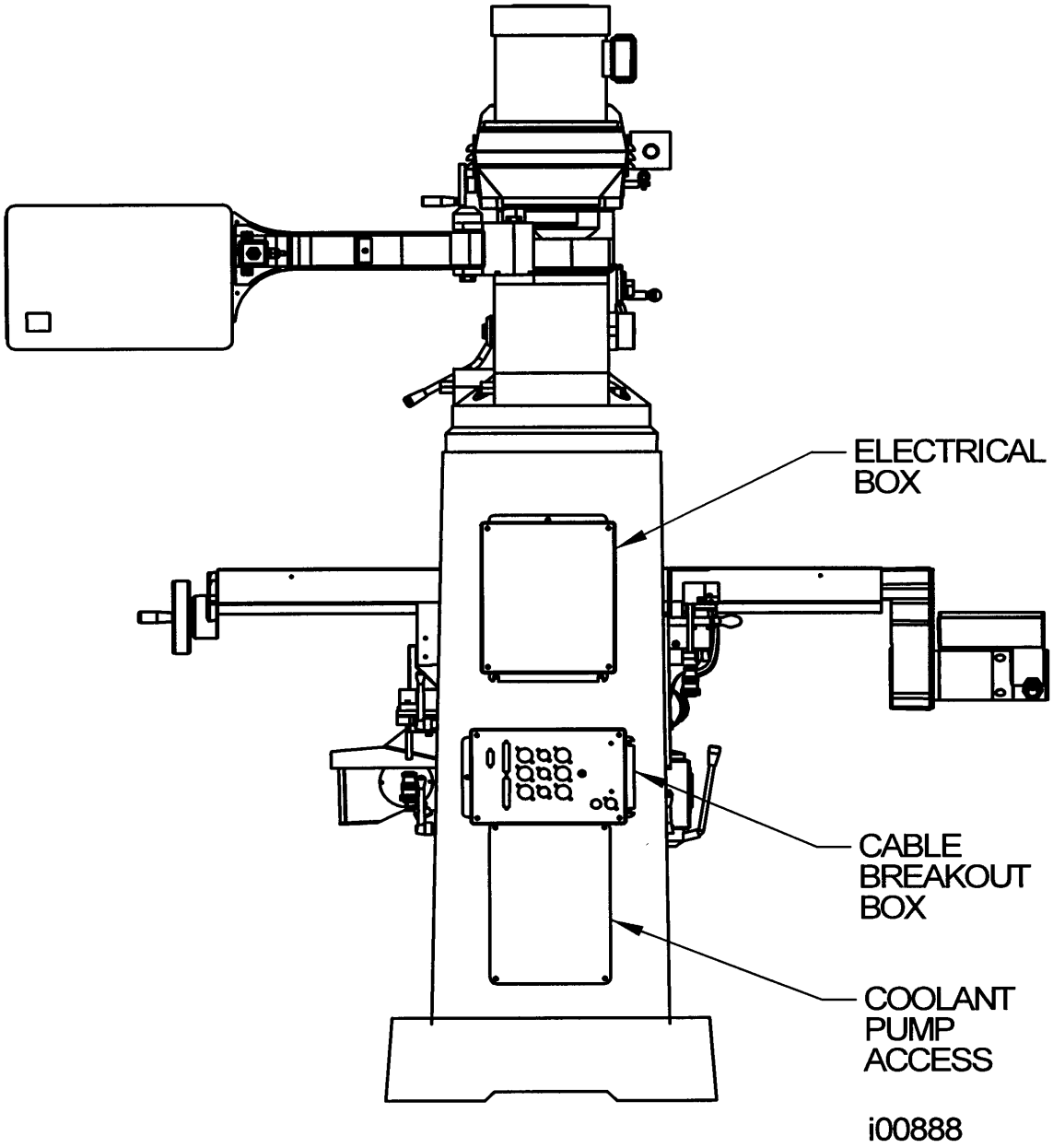


Figure 4 - Knee Mill Rear View

Item	Part Number				Description
	SMX K2/K3	SMX K2/K3 Spindle Control	SMX K4	SMX K4 Spindle Control	
1	220V=20676 440V=20676	24060-1 220V only	220V=20676-1 440V=20676	24060-2 220V only	Electrical Box
2	24999	24999	24999	24999	Cable Breakout Box
3	24999-1	24999-1	24999-1	24999-1	Cable Breakout Box with AUX Functions
4	9001	9001	9001	9001	Lube Pump
5	20676-2	n/a	20676-2	n/a	Electrical box (if have tableguard option)

2.8 Lifting and/or Moving the Machine

CAUTION!
The K2, K3 & K4 machines weighs approximately 2200, 2800 & 3600 lbs respectively. Proper equipment of sufficient capacity must be used when lifting and/or moving the machine.

(See Figure 5 To Prepare the Mill before Lifting):

1. Using a steel cable with protective sleeving (min 3/4" diameter) or a 3-ton sling, position sling loops on machine as shown in Figure 5.

2. Use cardboard pieces or other suitable protective sheets on both sides of the machine to prevent scratching.

3. Remove the 4 nuts and screws holding the machine to the wood skid.

4. Lift the machine (the machine should lift approximately level).

5. Insert the 4 screws for leveling pads in their place in the bed.

6. Place the machine in its location (see floor plan and bed footprint drawing). Carefully positioning each leveling pad under each leveling screw.

7. Remove the lifting cable or sling and all protective cardboard.

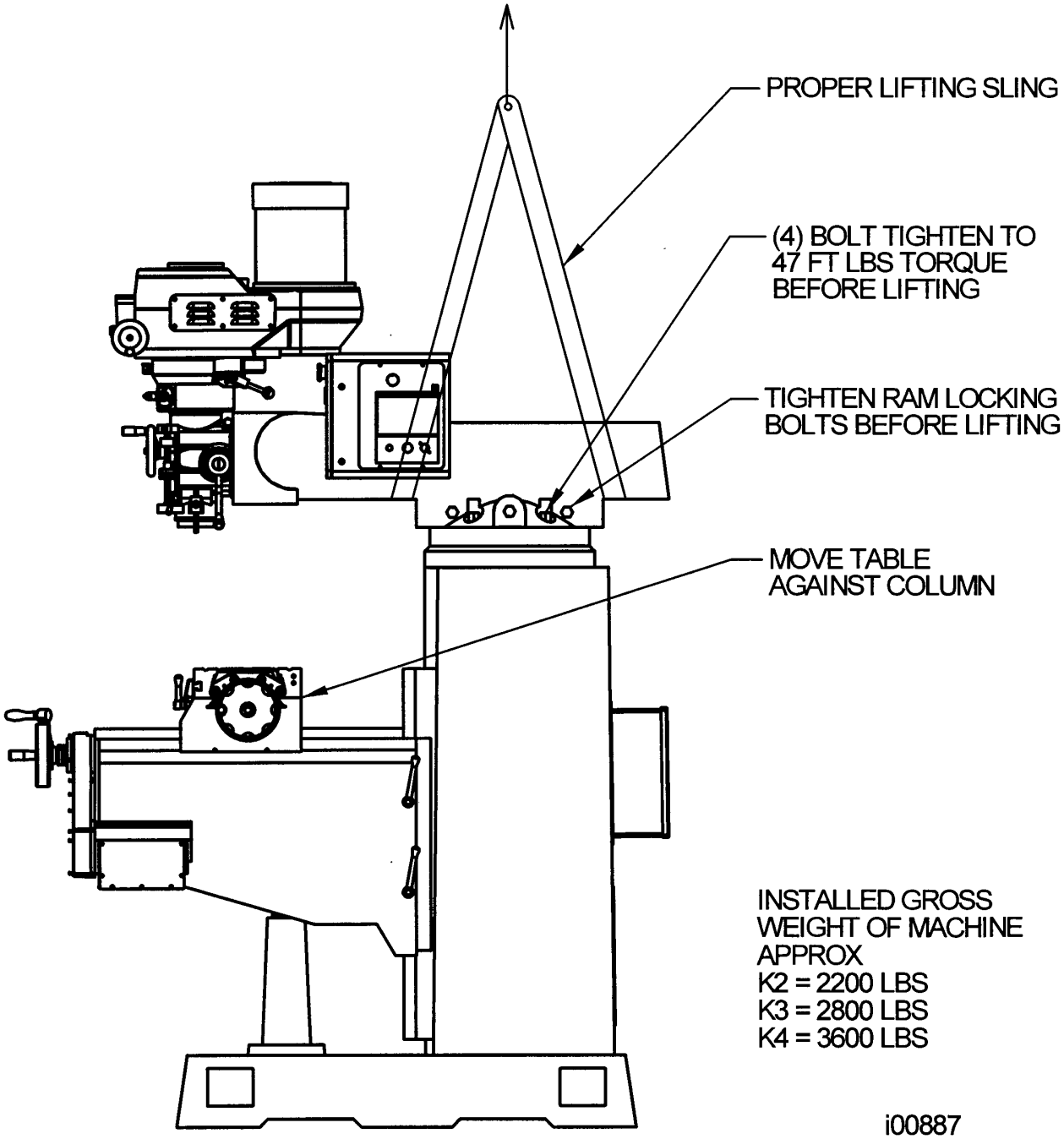


Figure 5
Lifting the Machine

2.9 Cleaning

1. Remove rust protective coating from the machine before moving any slideways (table, saddle, knee, etc.).
2. The coating is best removed with clean, dry rags. Do not use a cleaning solution that may damage the rubber way scrapers, plastic parts, or paint.

WARNING!
Do not use gasoline or other flammable cleaning agents for cleaning the machine.

3. It may be necessary to move back and forward, left and right, and up and down the table, saddle and the ram. Always release the clamp levers (two in front of the table, one underneath the saddle on each side, and two ram lockbolts on the right side of the column) before attempting to move the above parts.

CAUTION!
Never move any of the above parts over ways that were not previously cleaned. Serious damage to the TURCITE surface of slideways can occur.

4. Be certain the table, saddle and spindle move freely and smoothly over their entire length.

2.10 Leveling: Leveling Tolerance is .0005”/10”

1. Set the machine on its 4 leveling pads on a solid, level floor prepared in accordance with the state and local rules for machine tool installation.
2. Put one or two precision Spirit Levels or Electronic Levels in the center of the table in the positions illustrated in Figure 6.
3. Adjust the 4 corner leveling screws on their pads until the machine is level to .0005 in/10 in.
4. If the machine must be anchored to the floor, follow the general instruction for installing machine tools and use for leveling any well-known methods: shims, etc.).
5. If the machine must be installed on vibration mounts/pads (rubber, commercially available leveling and vibration mounts, etc.) follow the instructions delivered with the mounts/pads, ordering them to satisfy the load of the machine and the maximum weight of the workpiece.
6. When machine is correctly level, lock the adjusting screws in place with their hex nuts.

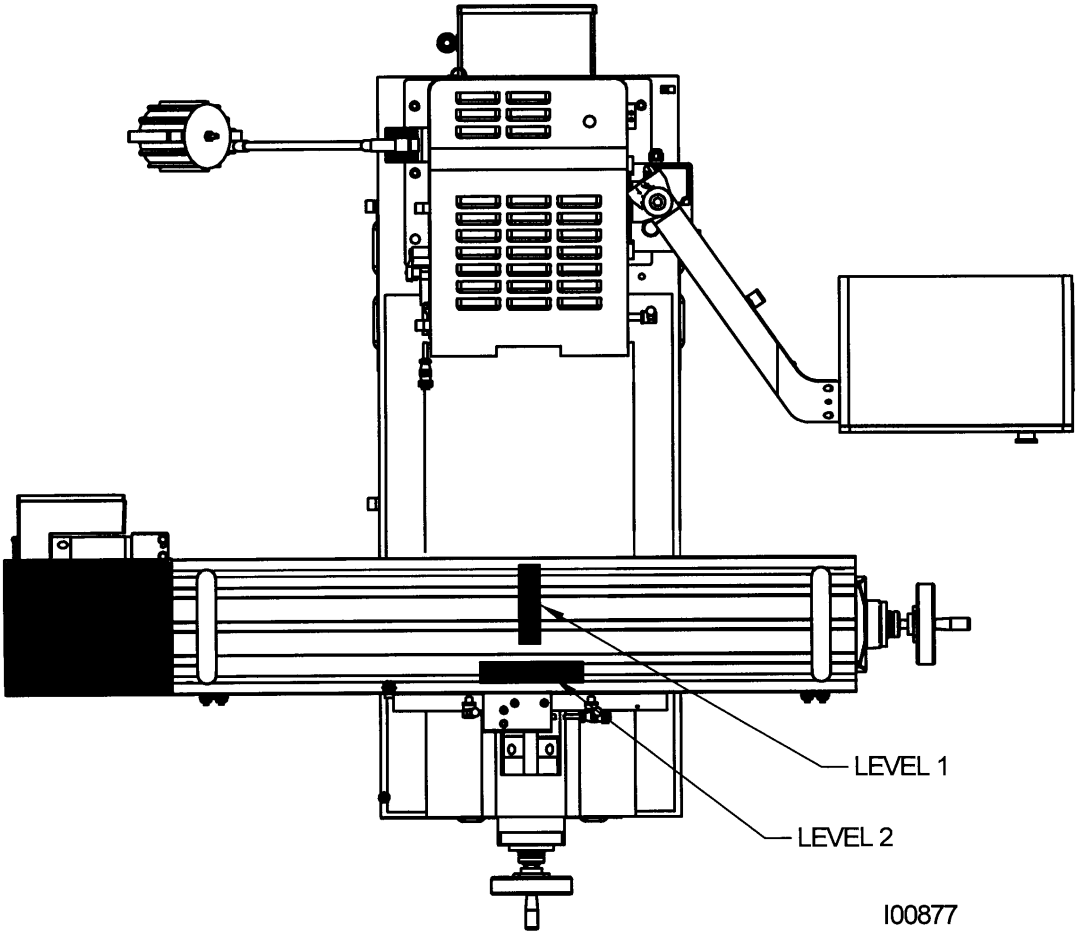
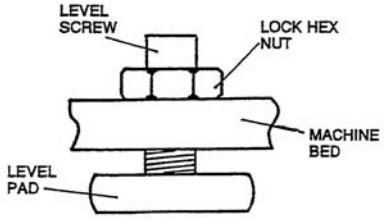


Figure 6
Placement of Levels



Item	P/N	Title
1	FC112	LEVEL SCREW
2	FC113	LOCK HEX NUT
3	FC114	LEVELING PAD

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Figure 7
Leveling Screws

2.11 Electrical Connection

The TRAK K2, K3 & K4 Knee Mills can be configured for 220 or 440 volt 3 phase electricity. These machines also require a 110V power source to power the control. **NOTE: Machines with Optional Spindle Control is only available in 220 V configurations.**

DANGER!
Be certain that 200-volt electricity (typical range 208 – 240V) is used only with a machine labeled 220 volts at the motor and at the electrics box on the back of the column.
Be certain that 400-volt electricity (typical range 415 - 460V) is used only with a machine labeled 440 volts at the motor and at the electrics box on the back of the column.

DANGER!
The 220 or 440-volt line must originate from a dedicated and independent fused box with a manual shut-off lever. It is the responsibility of the purchaser to supply a wired box that meets all local codes and regulations.

Incoming 220 or 440-volt power connects to the machine through the electrical box located on the back of the column. The power cable enters the black box through a hole on the top of the box.

DANGER!
Only a qualified electrician should wire the 220 or 440-volt 3-phase electricity.

To convert a K2 or K3 machine from 220 to 440 volt power or vice versa 3 things must happen: spindle motor must be rewired, overload relay must be set to 8.5 amps for 220 V and 4.25 for 440 volts and the voltage stickers on the electric's box must be replaced.

To convert a K4 machine from 220 to 440 volt power 3 things must happen: spindle motor must be rewired, overload relay must be replaced and set to 14 amps for 220 V and 7 for 440 volts and the voltage stickers on the electric's box must be replaced.

NOTE: Voltage conversion from 220V to 440V not applicable to machine fitted with the Spindle Control Option.

See Section 5.1.12 for a diagram of how to rewire the spindle motor.

Southwestern Industries recommends the machine be earth grounded by driving a copper rod into the ground. It is the responsibility of the customer to install this rod.

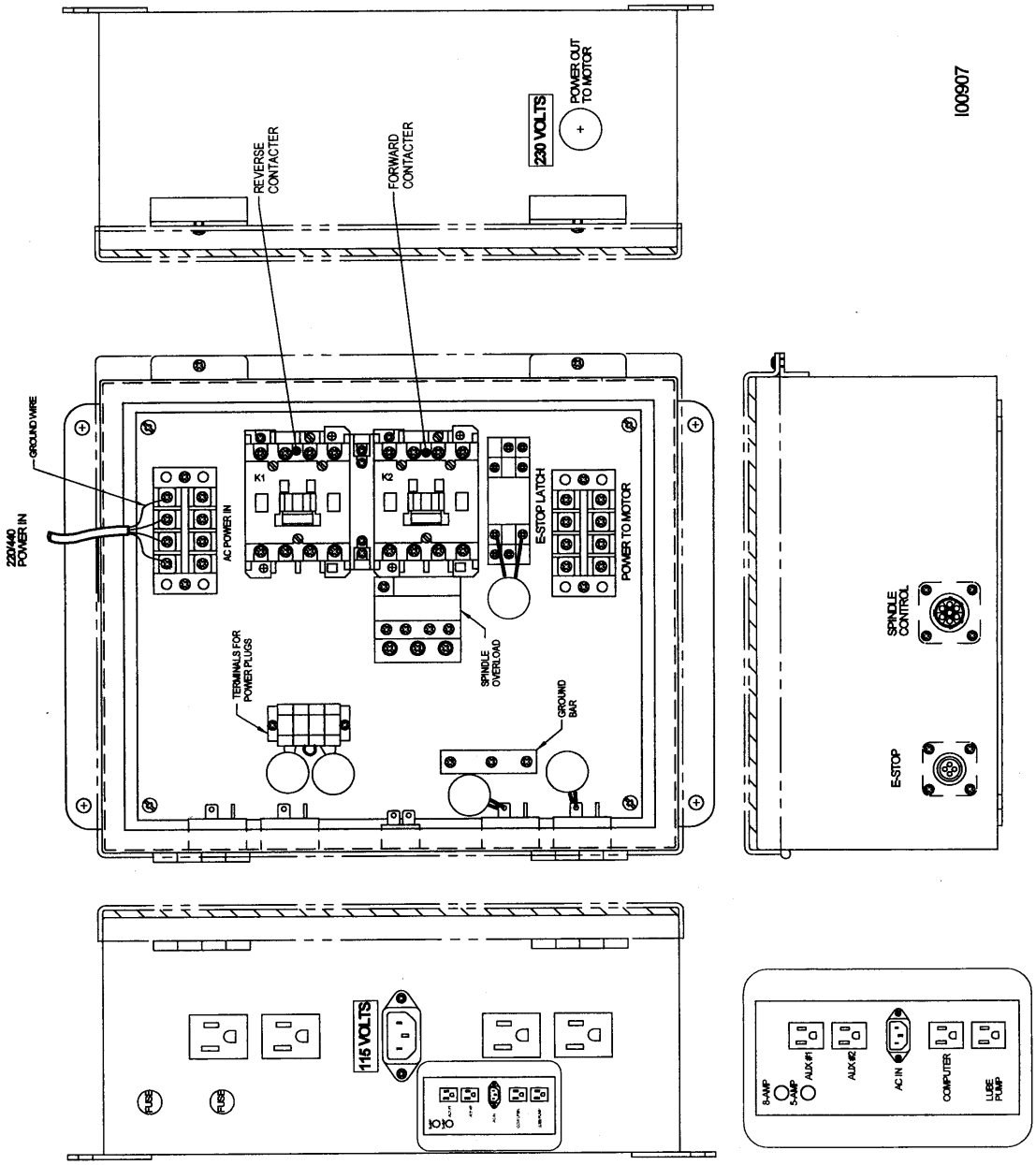


Figure 8
Wiring K2, K3 or K4 – Non Spindle Control
Not for retrofit

Part Number	Description
K2/K3/K4	
220V & 440V = 20676	Electrical Box
220V & 440V = 23438-3	Overload
23436	Contactor (Qty = 2) (Reverse or Forward)

NOTE: If equipped with Table Guard Option, the Electrical Box the P/N is 20676-2.

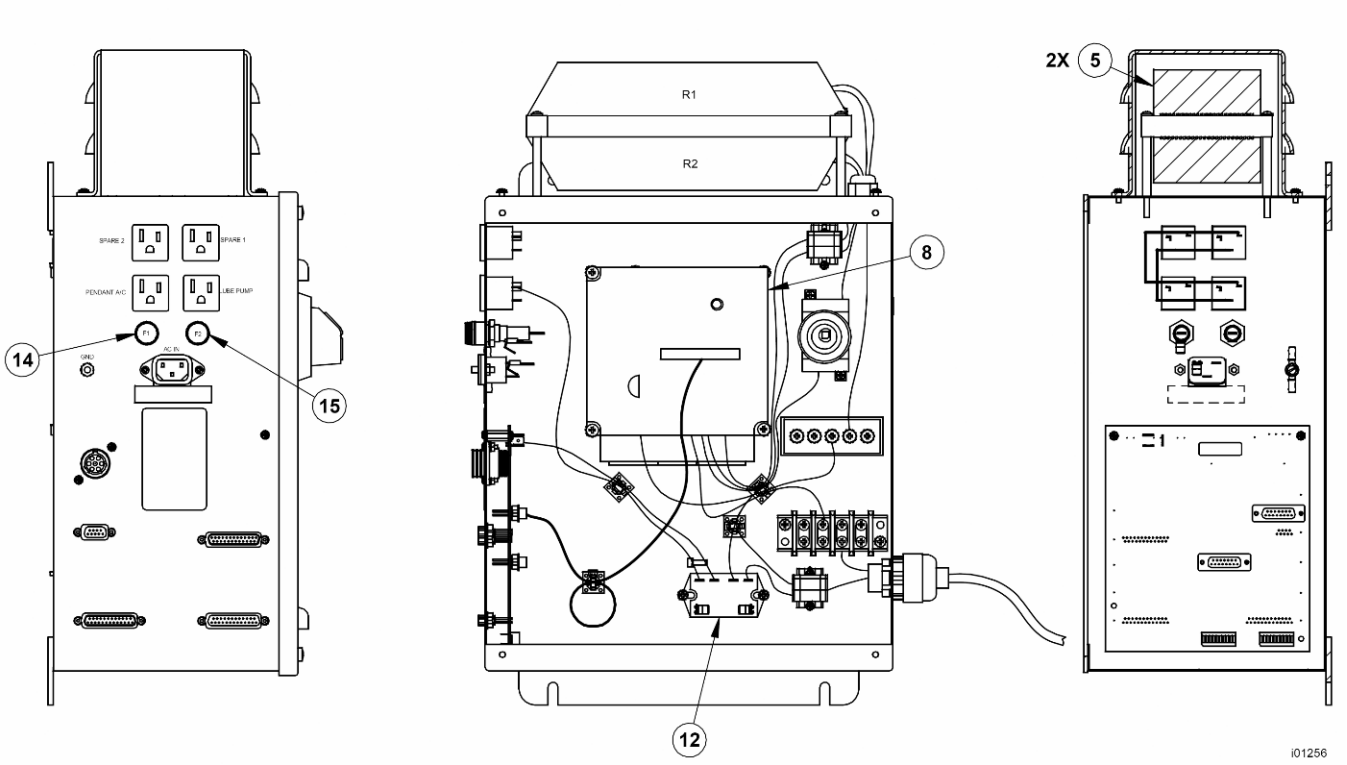


Figure 9
Wiring the K2, K3 or K4 – Spindle Control

Item	Part Number		Description
	K2/K3	K4	
1	24060-1	24060-2	Electrical Box
5	22890-500-120	22890-500-64	Resistor (Qty = 2)
8	25105-K2/K3SX	25106-K4SX	AC Drive - Mini Vector - 220V
12	22961		Relay - Power - 115V DPST
14	21824-5		Fuse - 3 AG - Slow Blow 5 AMP
15	21824-8		Fuse - 3 AG - Slow Blow 8 AMP

See Figure 117 in the rear of the manual for a more detailed breakdown of parts.

Southwestern Industries recommends the machine be earth grounded by driving a copper rod into the ground. It is the responsibility of the customer to install this rod.

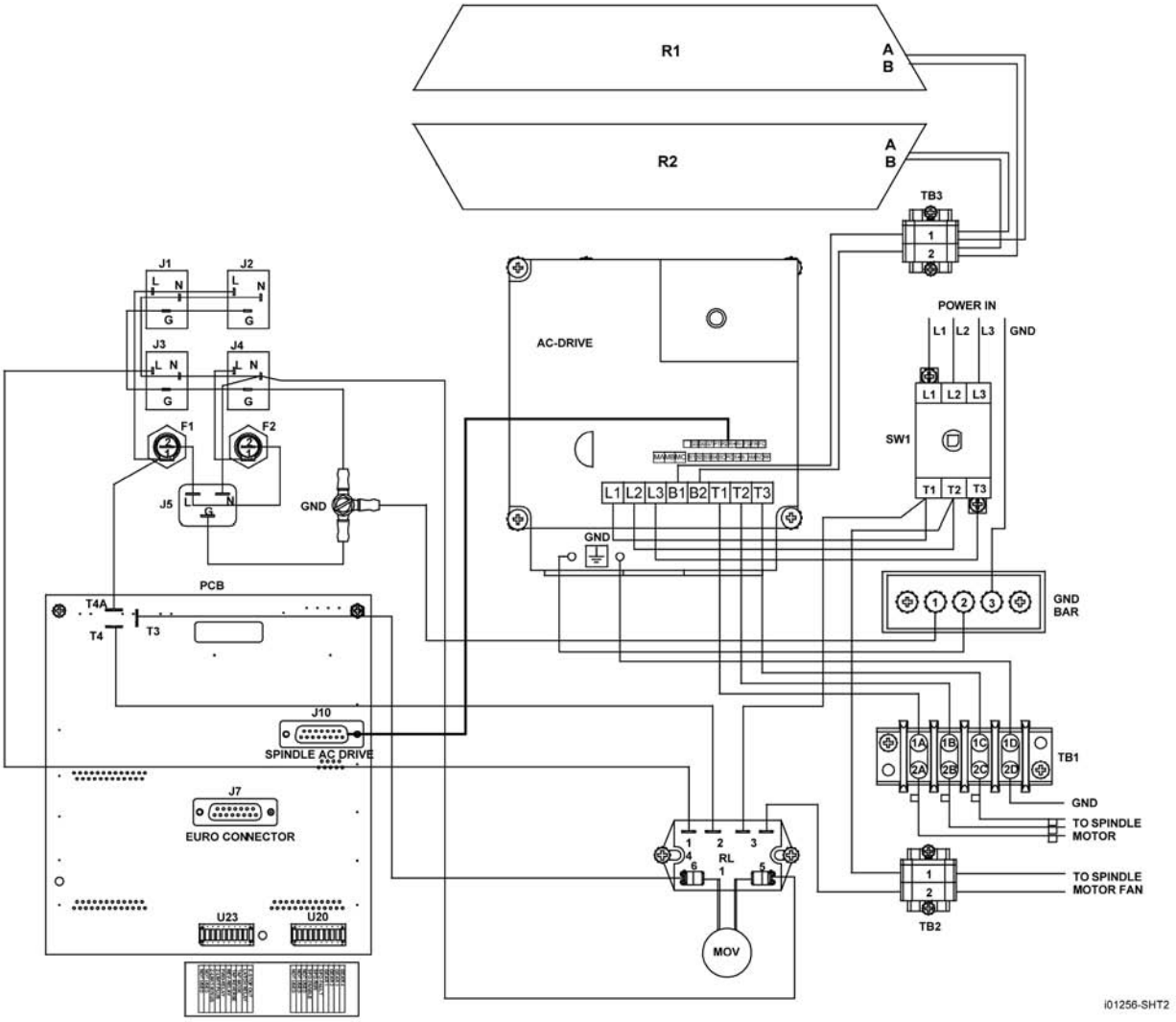


Figure 9-1
Wiring the K2, K3 or K4 – Spindle Control

2.11.1 Phase Converters

For those machines that will be run with a phase converter it is recommended that it is a rotary type rather than a static phase converters. Rotary phase converters allow for varying loads in the system. The electrical load on the machine will vary based on the type of cut taken. Static phase converters can only be used on machines with a non-varying load. The phase converter for the K mill machines must be rated at a minimum of 5 KVA for the K2 and K3 and 7 KVA for K4.

2.11.2 Flange Disconnect / Transformer (Optional)

The Flange Disconnect Option eliminates the need for the user to provide a power disconnect for the machine on their own, while the Transformer Option allows the user to provide one power source to the machine. **Note: This option is not available to machine fitted with the Spindle Control Option.**

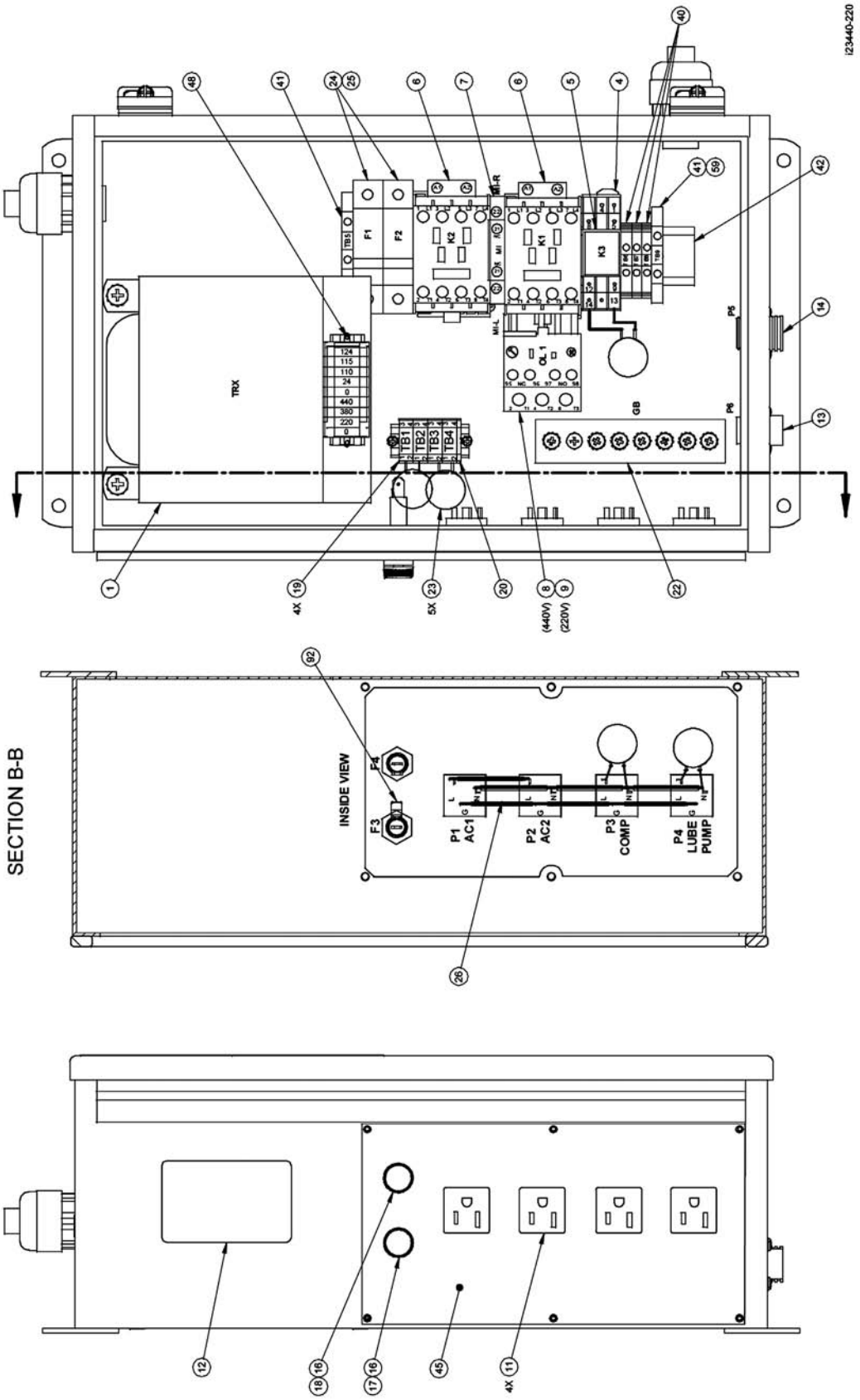


Figure 10 – Flange Disconnect/Transformer Option
P/N: 23440-220, 23440-1-220, & 23440-440

Parts List – Flange Disconnect / Transformer

Item	P/N	Title	Qty
1	21258	TRANSFORMER 1000VA EI	1
4	23434	SOCKET-RELAY	1
5	23435	RELAY-POWER-100-120 VAC-DPDT	1
6	23436	CONTACTOR-4 POLE	2
7	23437	MECHANICAL INTERLOCK	1
8	23438	OVERLOAD RELAY-440V	1
9	23438-1	OVERLOAD RELAY-220V	1
11	22199-1	RECEPTACLE- PANEL MOUNT NEMA STD 15A 125V	4
13	21871	CONNECTOR-4 POSITION-SIZE 11	1
14	23297-1	CONNECTOR-REVERSE SEX-13-7-CPC	1
16	21820	FUSE HOLDER	2
17	21824-5	FUSE-3AG-SLOW BLOW	1
18	21830-12	FUSE-TYPE 3AB-12A-SLO BLO	1
19	22868	TERMINAL BLOCK	4
20	22869	END PLATE	1
22	21753-3	GROUND BAR- 6 HOLE	1
23	21901-150	MOV-V150LA20B	5
24	23036	FUSE HOLDER-32 AMP-690V	2
25	23153-3	FUSE-600 VAC-TIME DELAY-CLASS CC	2
26	22303-16G	WIRE-BUSS-16 GA AWG 12" STRAIGHT	12.25
40	22557-1	TERMINAL BLOCK - 6mm BLOCK	3
41	24299-3	TERMINAL BLOCK-RAIL END STOP/ GROUND	2
42	22571-8.125	RAIL-DIN	8.13
45	23429	SHEETMETAL-COVER PLATE LEFT-PT4-SM TRANSFORMER OPTION	1
48	24407	NAMEPLATE - TRANSFORMER	1
		i23440-220	

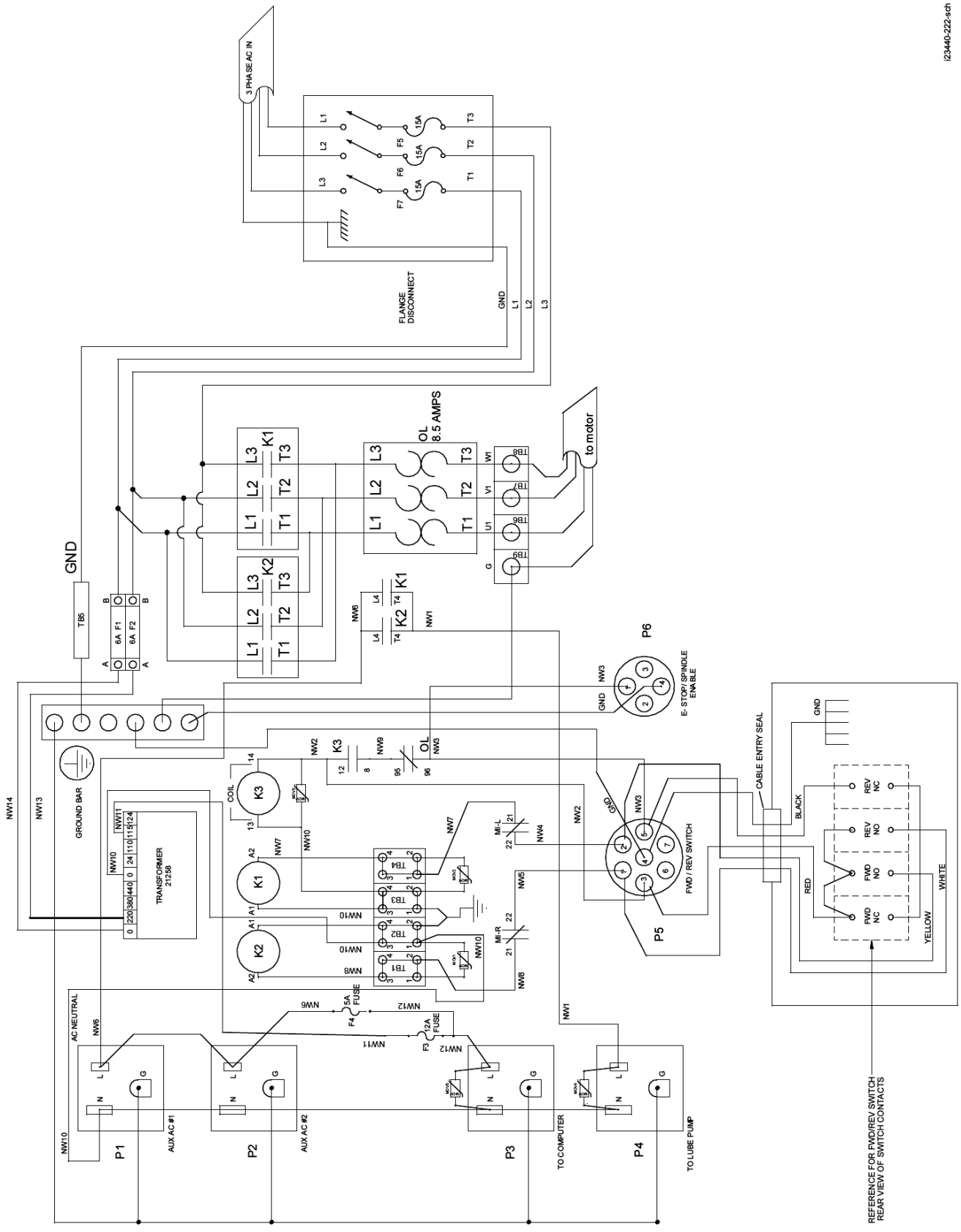


Figure 11
Transformer Option Schematic

2.12 Air Connection - Optional

The K mill machines have an air hookup in the rear of the machine if the machine has a power drawbar or auxiliary function option. Auxiliary function options are only found on 3 axis mills.

If the machine has a power drawbar option then the machine will include an air regulator, air manifold and an oiler. The air fitting is ¼" NPT. Within the manifold there is an additional air line port in case the user wants to hook up an air line to clean chips. Remove the plug to gain access to this port. If the machine has an auxiliary function option then the machine will include an air solenoid as shown below.

The air regulator is set to 90 psi at the factory for the power drawbar unit and solenoid. See Section 5 for more information on the power drawbar unit. The air comes in through the manifold, and then into the air regulator that tees off into an oiler for the power drawbar unit and into an air solenoid. The solenoid is used for a misting system the user may install later on this machine. There is a ¼" quick disconnect air fitting on the solenoid where the mister air hose can be plugged into. See the figure below for an illustration.

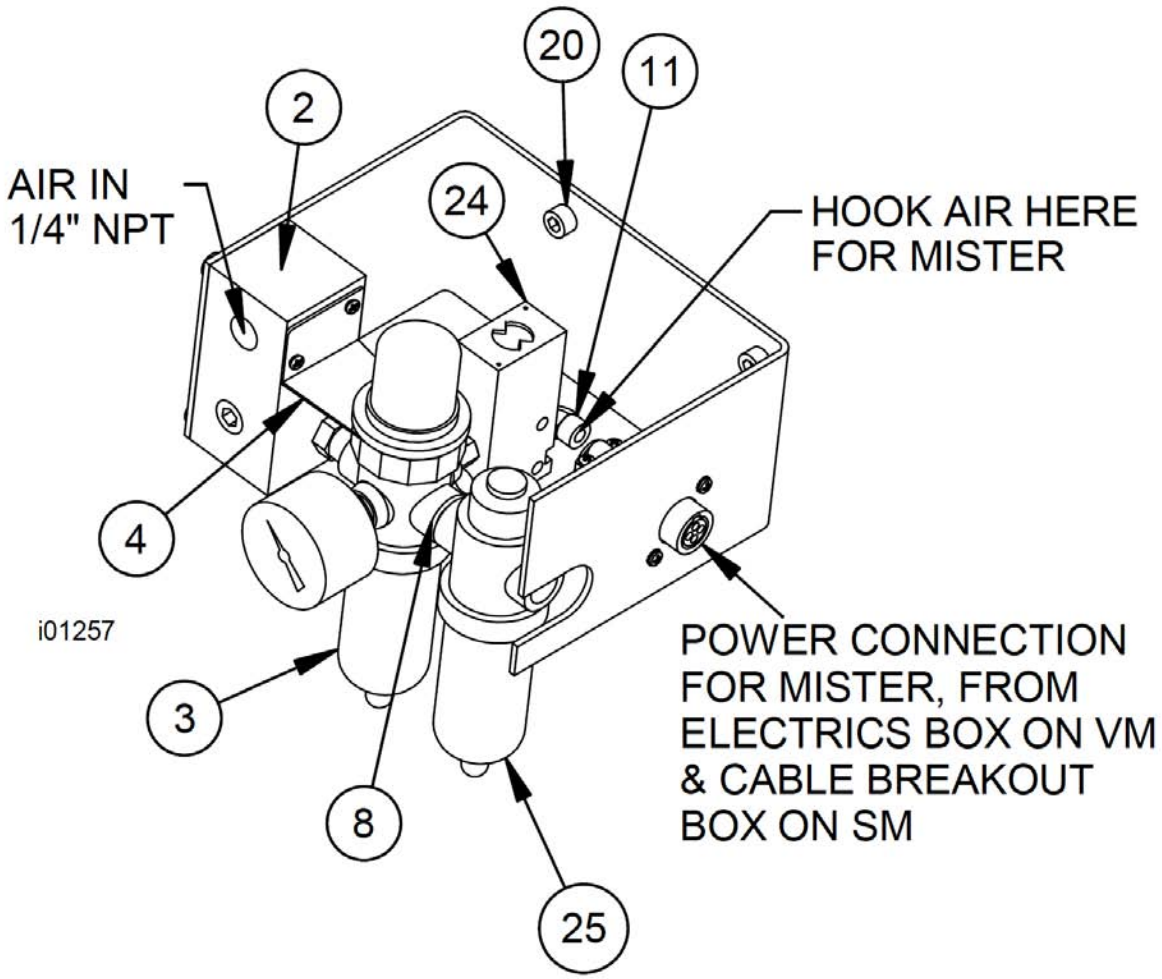


Figure 12 - Air Regulator/Solenoid Assembly - P/N: 22380-1

Item	P/N	Title	Qty
2	22378	MANIFOLD-PT4 AIR	1
3	22607	FILTER/REGULATOR-PT4	1
8	22644-4	PLUG-1/4 NPT HEX SOCKET	3
9	22645-4	NIPPLE-1/4 NPT x 1.37 LG	1
11	22646-4	ADAPTOR-ELBOW MALE 1/4 x 1/8 NPT	1
12	22647-2	NIPPLE-1/8 NPT x 0.750" LG	1
18	4-40X3/8 31B	SCREW-PH-PHIL-EXT SEMS-STL-BO	2
19	10-32X3/8 10B	SCREW-PH-PHIL-STL-BO	2
20	M6-1.0X25 25B	SCREW-SHCS-STL-BO	2
24	22772	SOLENOID ASSY- AIR REGULATOR	1
25	22581-5	OILER	1

i22380-1

2.13 Mounting the Display Pendant

The ProtoTRAK SMX display pendant mounts to the pendant arm with four 1/4-20 x ¾ SHCS that are shipped screwed into the left side of the display. There is a locating screw on the pendant arm to help align the pendant with the mounting holes.

CAUTION!
The locating screw in the arm is used for positioning. Keep a hold of the pendant until the screws are fastened.

If the pendant arm rotates too freely, remove the painted cap on the bracket attached to the column and tighten the hex nut to adjust it. Replace the cap.

2.14 Cable Interconnections

All cable interconnections are made at the factory except for those connecting to the pendant display. There are a total of 4 cables that need to be connected to the pendant for non-spindle control machines. See Figure 15 & 16 for a complete illustration of cable interconnections for all components. There are an additional 2 cables for the electronic handwheel option and 2 more cables for the spindle control option (digital I/O and spindle control ports).

With the main power to the machine turned off, plug in the connectors that are bundled on the pendant arm. Each cable mates to only one connector on the pendant display back panel. Use the key on the pendant to match up the connectors with the correct port. The machine ID port (or called LPT) and parallel port (hardware key) will have a key plugged into it. The monitor port and network ports will be left empty during installation.

Make sure there is sufficient slack in the cables for when the pendant is rotated about the pendant arm. The worst case is when the pendant is all the way forward toward the operator. The following drawing describes all of the cable connections to the pendant.

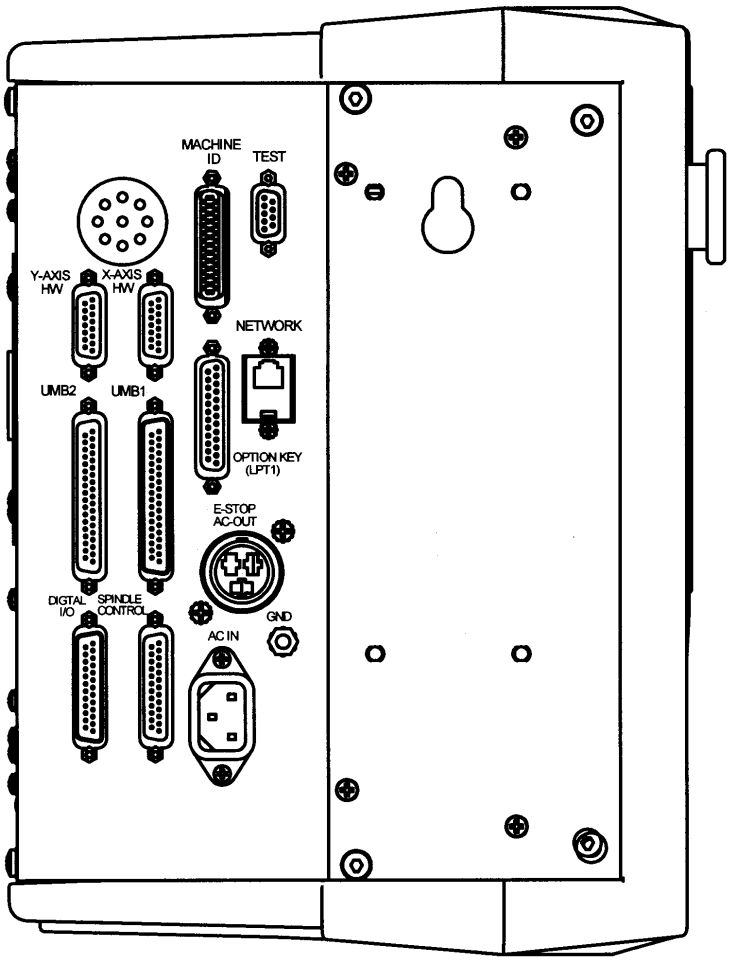
Make sure there is a hardware (option) key plugged into the parallel port of the pendant. This key activates any converters or options ordered. The part # for this key is 22648. The key must be programmed according to the type of machine it is on and the options ordered.

Make sure the machine ID key is plugged into the machine or it will not run. Note: Spindle control machines use a different machine ID key then non-spindle control machines.

Whenever you replace a cable or reroute a cable it is very important to keep the power cables and logic cables separated from each other. The power cables consist of the (3) 110-volt motor cables and (2) 110-volt power cables for the pendant, and a coolant pump or solenoid power cable. The logic cables are used to carry encoder signals between the cable breakout box and computer module. Mixing of the power and logic cables may cause noise from the power cables to interrupt the signals in the logic cables. This can lead to intermittent axis faults or repeatability problems. See Figure 15 and 16 for a layout of the cable connections.

CAUTION!
Make sure the main power is turned off on the back of the electrical cabinet before plugging in the cables.

Figure 13
Pendant Cable Connections
Left Side
P/N: 24000-1



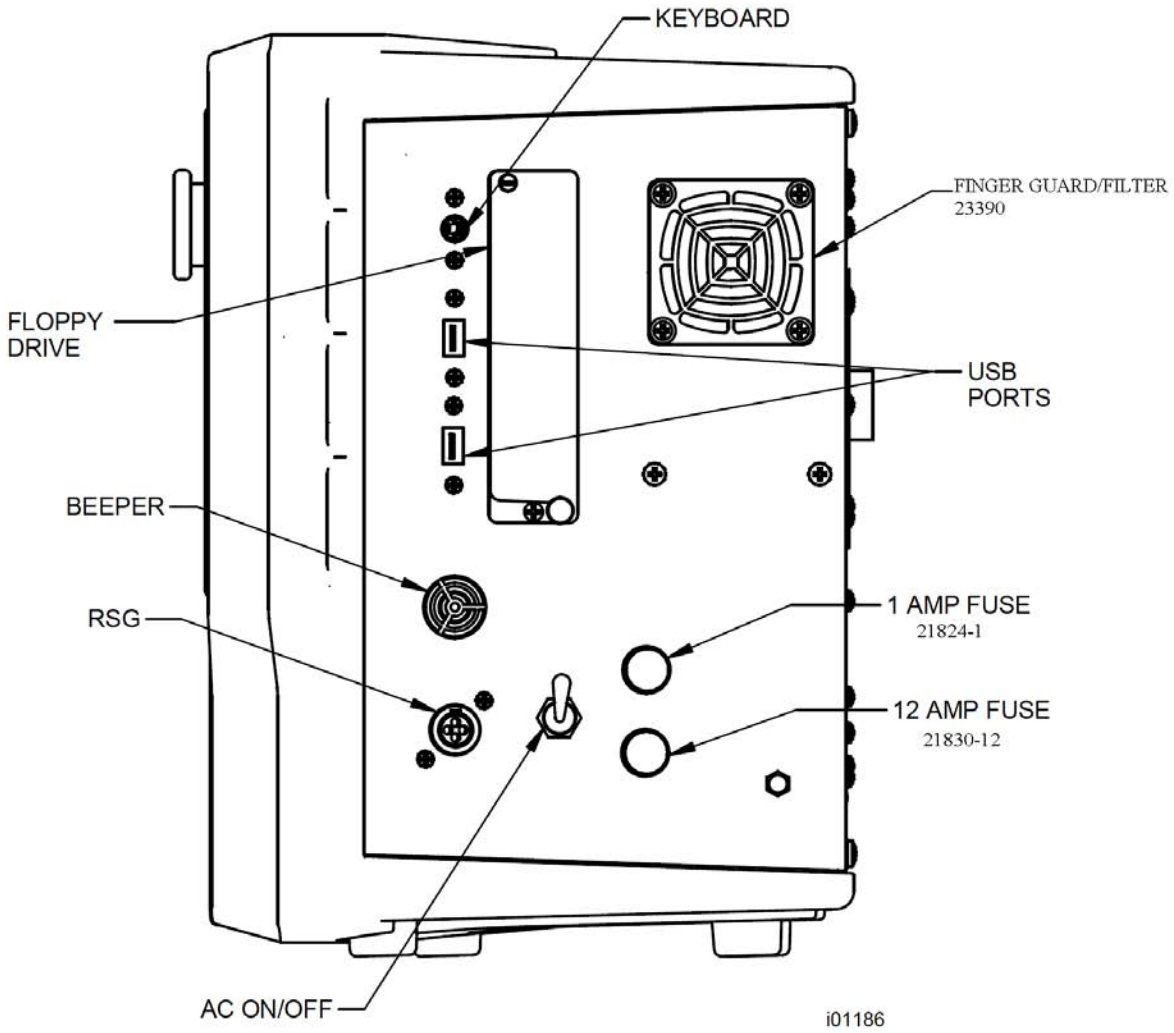


Figure 14
Pendant - Right Side
P/N: 24000-1

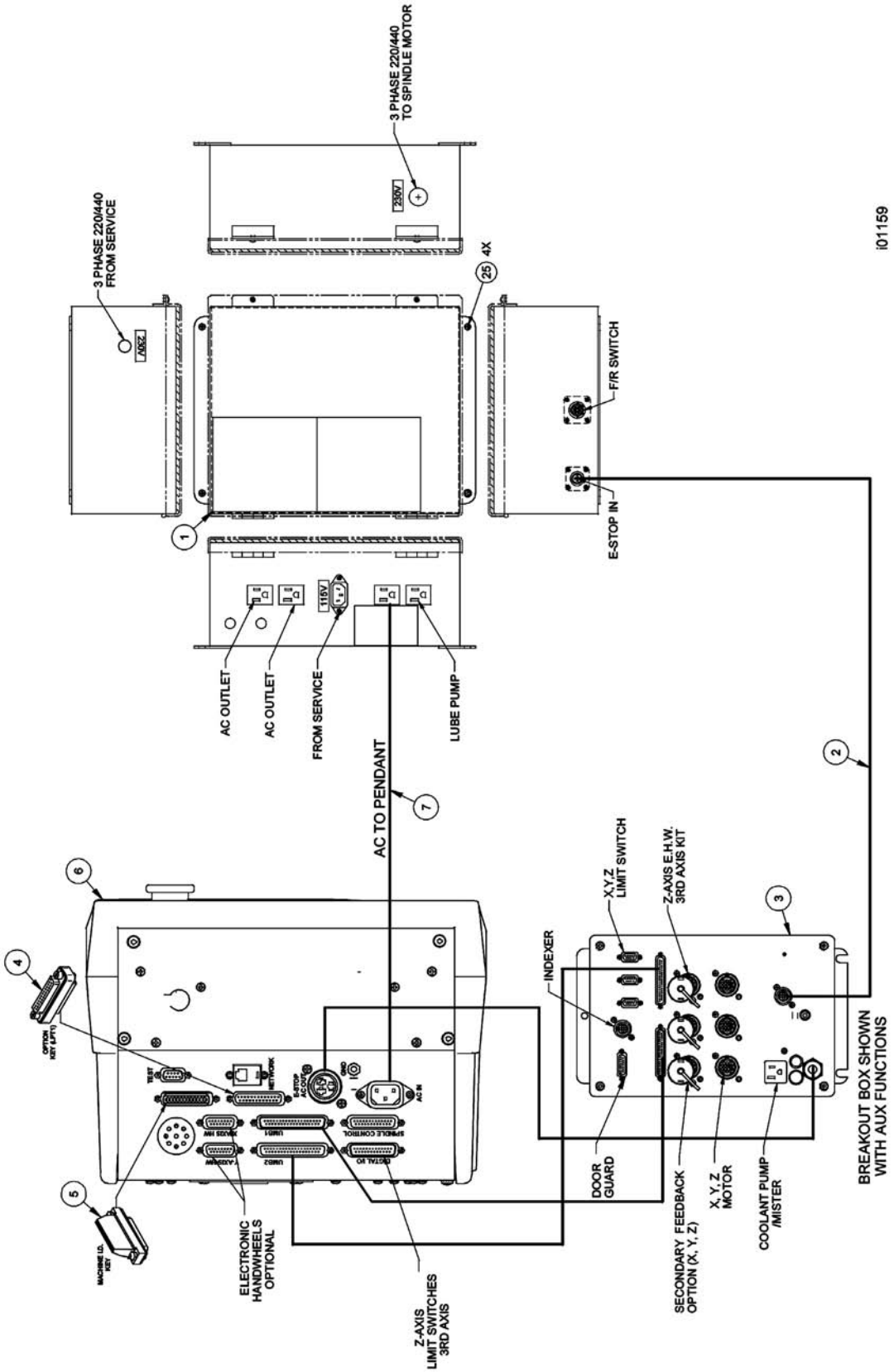


Figure 15
Cable Connection Diagram
Non-Spindle Control

Figure 15
Cable Connection Part List
Non-Spindle Control

Item	Part Number		Description
	K2/K3	K4	
1	220V = 20676 440V = 20676	220V = 20676-1 440V = 20676-1	Electrical Box
2	21856		Cable Assembly
3	24999		Cable Breakout Box (-1 with AUX Functions)
4	22648-7		Option Key—SMX
5	22758-SKNEE2X		Key—Machine ID
6	24000-1		SMX Pendant

Figure 16 Part List for
Cable Connection Diagram with Spindle Control
See next page

Item	Part Number	Description
1	24000-1	SMX Pendant Assembly
2	24060-1	Enclosure Assembly, SX2
2	24060-2	Enclosure Assembly, SX3 and SX5
3	24999	Cable Breakout Box No Aux
3	24999-1	Cable Breakout Box With Aux
4	22555-10	Cable Assy - Logic
5	22555-10	Cable Assy - Logic
6	22556-10	Cable Assy - Parallel
7	22556-10	Cable Assy - Parallel
8	22608	Power Cord
9	20267	Cable Assy - AC to Computer

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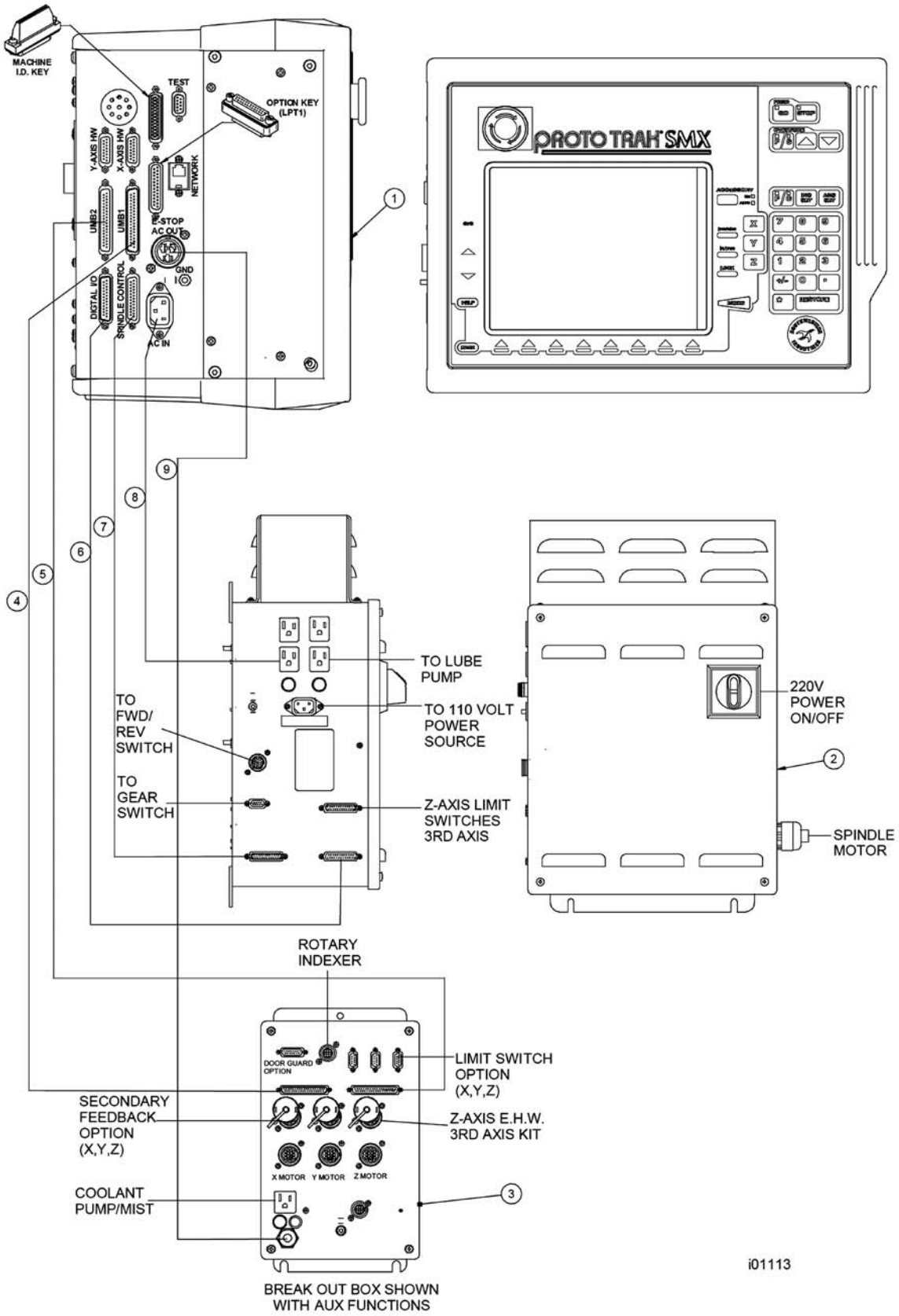


Figure 16
Cable Connection Diagram with Spindle Control

2.15 Lubrication

CAUTION!
Failure to properly lubricate the mill will result in the premature failure of bearings, sliding surfaces & ballscrews

2.15.1 Manual Lubrication

The TRAK mill X & Y way surfaces and ball screws need to be manually lubricated. The Manual Lube automatically discharges about 4ml of oil every plunge.

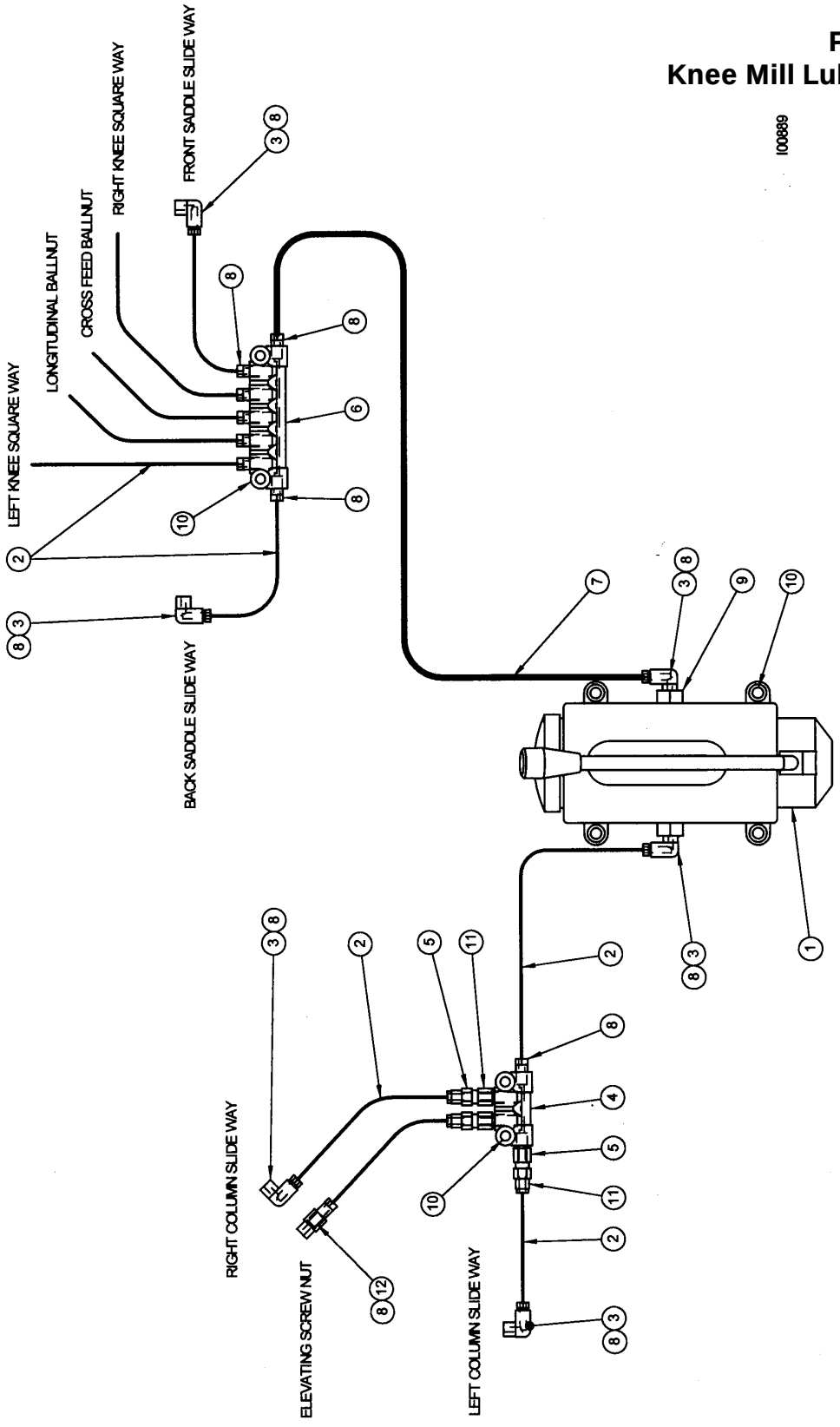
1. At the beginning of each day, manually pull the pump handle.

Note: If the machine has been sitting for a long while, run the machine through the full length of its travel to ensure lubrication reaches all surfaces.

2. At the beginning of each day, check the oil level in the system. If low, fill with Mobil Vactra Oil No. 2 or equivalent.

CAUTION!
Failure to manually activate the pump at the beginning of each day and allowing the pump to run dry may cause severe damage to the TRAK mill way surfaces and ball screws.

Figure 17
Knee Mill Lubrication



Parts List – Figure 17, Knee Mill Lubrication

Item	P/N	Title	Qty
1	9001	HAND OILER	1
2	9002	ALUMINUM PIPE	6
3	9003	ELBOW	6
4	9004	T-JOINT - 4 HOLES- M8 X 1.0	1
5	9005	CONNECTOR	3
6	9006	REGULATING DISTRIBUTOR	1
7	9007	FLEXIBLE TUBE - 21 inches	1
8	9008	SCREW NUT - M8 X 1.0 MALE	15
9	9009	SCREW NUT - PD 1/8- 19MM	2
10	9010	SCREW - M5 X 20 mm LG	8
11	9011	SCREW NUT - M8 X 1.0 FEMALE	3
12	9012	ADAPTER	1
13	9013	SLEVE - 4.1 mm I.D.	18

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2.15.2 Head Lubrication

Once Each Week:

1. Fill the oil cup on the front of the head with SAE 30 or 30 W oil. This oil lubricates the Hi/Lo range shifter.

2. Extend the quill fully and apply a coating of SAE 30 or 30W oil to the outside diameter of the quill.

Every Four Months:

1. Apply a good grade of general-purpose grease through the grease fitting on the back of the head. This grease lubricates the Low-range gear set and the feed-change gears.
2. Grease vari-disk on spindle motor through the grease fitting on the motor shaft.

2.16 ProtoTRAK SMX Euclid Block Procedure

The test part should be machined at the completion of the installation.

The material for the Euclid block test part is found in the toolbox.

- Material Specification: Aluminum, 6061-T6 or T4
- Blank Size: (minimum dimensions) 3 x 3 x 1", provided in tool box
- Tool: .750 end mill, 2 flute, high speed steel, ***sharp***
- Coolant: Flood coolant or Cool-Tool

1. Mount vise and indicate the back jaw parallel to the table within .0005".
2. Clamp material in vice with a minimum of .800" above the vise jaws.
3. Load in the Euclid block program from the ProtoTRAK SMX flash disk, which is Part Number Euclid 2 axis.PT4. It is found under the PT4 folder followed by the SWI TEST PROGRAMS folder.
4. Use an edge finder to set Absolute 0 on X and Y. Absolute zero is the front left corner of the block as viewed from in front of the machine.

5. Load the .750 end mill and set Z Absolute 0 at the top of the part.
6. Begin to run the program. Set the spindle to 2000 RPM and follow the instructions on the control for SETTING Z and CHECKING Z. The part will be machined in the following sequence:

Event #	Description	Depth of Cut
1	Circle pocket – cuts middle circle	-0.250”
2	Circle frame – cuts outer 1.830 diameter circle	-0.250”
3	Circle frame – cuts material from corners remaining on Euclid block	-0.250”
4	Roughs material in upper right-hand corner	-0.500”
5-12	Cuts triangle on Euclid block with finish cut	-0.500”
13	Rectangular frame – cuts outer 2.750” rectangle	-0.750”

7. After the program run, the program will locate to the following position.
    - X = 1.318
    - Y = 1.318
8. Mount a dial indicator in the quill and check the circles.
9. Check the runout of the sides of the square frame.
10. Inspect the machined surfaces for smoothness.

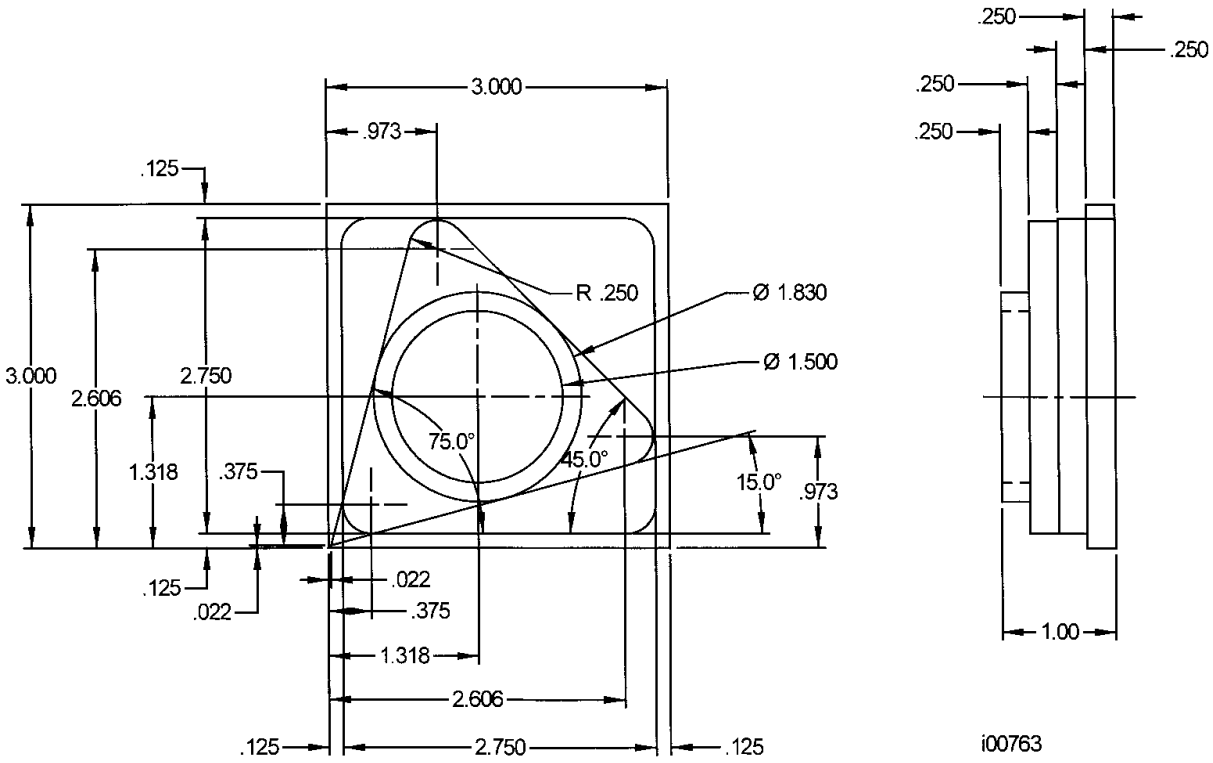

Figure 18
Euclid Block

3.0 Troubleshooting by Symptom

Use this section to begin the process of resolving a service problem. Each symptom type is described in a few words and then more fully described in an explanatory paragraph. Following this is a chart that directs in the most logical steps

3.1 Problems Relating to Machining Results

3.1.1 Poor Finish

The part finish is marred with scallops or is very rough.

Do the following Service Codes and document values:

- **Code 33** Software Identification. This is needed if you call SWI Customer Service.
- **Code 11** Measures backlash in the system (Only used on Dual Feedback systems)
- **Code 12** Feed Forward Constant
- **Code 127** Measures backlash in the system (for Z-axis on three-axis systems; not used on Dual Feedback systems,)
- **Code 128** Enter backlash compensation (for Z-axis on three-axis systems; not used on Dual Feedback systems)

Possible Cause	Check This
Too much backlash entered for code 128 or calculated with code 11.	Verify nothing is mechanically loose and the backlash values are not higher than what physically is in the system.
Machine Tool & Setup problem	Check for any looseness in the setup (Tool, Tool holder, Part, Vise, or Fixture). Check the condition and type of cutter being used, type of material, RPM and Feedrate, etc. See Machine Tool & Setup Section 4.1
Table, Saddle, or Knee Locks are locked	Make sure the Table and Saddle Locks are unlocked. Never use gib locks with a CNC machine.
Inadequate or no Lubrication to Ballscrews and Way surfaces	Make sure all the Way surfaces are getting proper lubrication. If not, check to make sure that the lube pump is functioning properly. Also check for any pinched or blocked oil lines. See Lubrication Section 4.1.3
X, Y, and knee Gibs are not adjusted properly	Check the adjustment of the X and Y gibs. See X and Y Gib Adjustments in Section 5.2.1.
X & Y-axis Drive Trains are loose	Check Repeatability using the Repeatability and Positional Accuracy procedure. Step by step, carefully inspect the Drive Train for any looseness. It may be necessary to disassemble and then reassemble the Drive Train. See Mechanical Drive Train (X, Y) Section 4.2
Way surfaces are pocked, scarred, or excessively worn	Visually check the condition of all the Way surfaces. For machines that may have excessively worn Way surfaces you may need to adjust the Gibs in this area. This will affect performance when using the machine outside of this area. Check lubrication to affected areas.

3.1.2 Circles Out of Round

Circles are not round within 0.002" TIR over 3.0" DIA. This is best measured by placing a dial indicator in the quill and sweeping around the part.

Note: The typical slideway-milling machine is not capable of achieving more precise results although careful adjustments to a new milling machine may produce better results. If more precise circles are required, then it is recommended to use a precision boring head/boring bar.

Do the following Service Codes and document values:

- **Code 33** Software Identification. This is needed if you call SWI Customer Service.
- **Code 11** Measures backlash in the system (Only used on Dual Feedback systems)
- **Code 12** Feed Forward Constant.
- **Code 127** Measures backlash in the system (not used on Dual Feedback systems).
- **Code 128** Enter backlash compensation.

Possible Cause	Check This
Torque values on X and Y-axis are too high.	Make sure torque is lower than 20 in-lbs. Normal values for a machine that is aligned and adjusted properly should be between 10 and 15 in-lbs. Make sure torque is consistent across axis travel.
Machine Tool and Setup problem	Check for any looseness in the setup (Tool, Tool holder, Part, Vise, or Fixture). See Machine Tool & Setup - Section 4.1
Machine not level	Verify that the machine is level to specification.
Head is not Trammed	Verify that the Head is Trammed to specification. See Tramming the Head Sec 5.2.3
X and Y Gibs are not adjusted properly	Check the adjustment of the X and Y Gibs using the X and Y Gib adjustment procedures.
Calibration or Backlash problem	Recalibrate the machine. Reset the Backlash. Check Repeatability and Positional Accuracy. See Calibration & Backlash Constants Section 5.2.2
TRAK Sensor or Glass Scale problem	Make sure that the Sensor or Glass Scale is installed correctly according to the Sensor or Glass Scale Installation procedures. Check for any loose brackets or misalignment etc. Also, check to make sure the Sensor or Glass Scale assemblies are functioning correctly. See TRAK Sensors or Glass Scales Sections 4.6 & 4.7.
X & Y-axis Drive Trains are loose	Check Repeatability using the Repeatability and Positional Accuracy procedure. Step by step, carefully inspect the Drive Train for any looseness. It may be necessary to disassemble and then reassemble the Drive Train. See Mechanical Drive Train (X, Y) Section 4.2
Head Bolts are loose	Verify that all the head bolts are tight. 50 lbs.

3.1.3 Taper Cut on a Programmed Straight Line Move

An unwanted tapered cut occurs, when the machine is programmed to move in a straight line along either the X or Y-axis. The DRO shows motion of a few thousandths of an inch in the axis that is not supposed to be moving.

Explanation: For straight line cuts along the X or Y-axis, the control is designed to lock the motor of the axis that is not moving. A taper is created when there is play in the system. The force of the tool shoves the table or saddle out of position.

The system will respond to being pushed out of position by making an adjustment at the end of the move.

An unwanted tapered cut is the result of looseness in the system.

Do the following Service Codes and document values:

- **Code 33** Software Identification. This is needed if you call SWI Customer Service.
- **Code 11** Measure's the backlash in the system. Only used on machines with Dual Feedback systems.
- **Code 12** Feed Forward Constant.
- **Code 127** Measure's the backlash in the system. Only used on machines with single Feedback.
- **Code 128** Enter backlash compensation.

Possible Cause	Check This
Machine Tool & Setup problem	Check for any looseness in the setup (Tool, Tool holder, Part, Vise, or Fixture). See Machine Tool & Setup Section 4.1
X and Y Gibs are loose	Check the adjustment of the X and Y Gibs using the X and Y Gib adjustment procedures. See Section 5.2.1
X and Y-axis Drive Trains are loose	Check Repeatability using the Repeatability and Positional Accuracy procedure. Step by step, carefully inspect the Drive Train for any looseness. It may be necessary to disassemble and then reassemble the Drive Train. See Mechanical Drive Train (X, Y) Section 4.2

3.1.4 Parts Have Incorrect Dimensions

Parts are being machined with dimensions that are different than those programmed. Typical accuracy expectations should be:

- **Circles:** 0.002" TIR over 3.00" DIA
- **Positional Accuracy:** +/- 0.0005"
- **Repeatability:** 0.0005"

Note: The typical slideway-milling machine is not capable of achieving more precise results. Although careful adjustments to a new milling machine have produced better results, you should not expect the same level of accuracy from an older or worn machine.

Furthermore, the system should be expected to repeat within the resolution of the displayed DRO numbers of 0.0005".
Do the following Service Code:

- **Code 33** Software Identification. This is needed if you call SWI Customer Service.
- **Code 123** Calibration.
- **Code 11** Measure's the backlash in the system. Only used on machines with Dual Feedback systems.

- **Code 12** Feed Forward Constant.
- **Code 127** Measure's the backlash in the system. Only used on machines with single feedback.
- **Code 128** Enter backlash compensation.

3.1.4.1 Every Part Has the Same Error

Possible Cause	Check This
Machine Tool & Setup problem	See Machine Tool & Setup Section 4.1
Programming Error	In the program, look for common errors in programming such as transposing numbers, tool diameters, and pressing INC SET when ABS SET is meant. This is especially suspected if the dimensional errors are larger than a few thousandths. See the Controls Programming, Operations and Care manual.
Configuration file that contains calibration file and backlash constants has been erased or corrupted.	Verify configuration file (Code 313) does not read default values. Load saved configuration file from floppy disk in electrics cabinet with Code 141.
Calibration or Backlash problem	Recalibrate the machine. Reset the Backlash. Check Repeatability and Positional Accuracy. See Calibration & Backlash Constants

3.1.4.2 The Dimensional Errors Are Random or Accumulate in Size Over the Part Program Run

Possible Cause	Check This
Machine Tool & Setup problem	See Machine Tool & Setup Section 4.1
TRAK Sensor or Glass Scale problem	Make sure that the Sensor or Glass Scale is installed correctly according to the Sensor or Glass Scale Installation procedures. Check for any loose brackets or misalignment etc. Also, check to make sure the Sensor or Glass Scale assemblies are functioning correctly. See TRAK Sensors or Glass Scales Sections 4.6 & 4.7
X and Y-axis Drive Trains are loose	Check Repeatability using the Repeatability and Positional Accuracy procedure. Step by step, carefully inspect the Drive Train for any looseness. It may be necessary to disassemble and then reassemble the Drive Train. See Mechanical Drive Train (X, Y) Section 4.2

3.2 Problems Regarding the Motion of the Machine

3.2.1 Run Away Axis

The axis makes an unwanted move at rapid speed in one direction and faults out. This is usually caused by an encoder signal being interrupted.

Do the following Service Codes:

- **Code 33** Software Identification. This is needed if you call SWI Customer Service.
- **Code 100** Axis open loop test. Used to check the maximum feedrate of an axis and if the encoders are counting properly.

Possible Cause	Check This
Sensors or glass scales are counting in opposite direction of motor encoder	Reverse directions with codes 321 and 322
The home positions or tools are not set correctly	See the Controls Programming, Operations and Care manual.
The Sensor or Glass Scale is not reading.	See TRAK Sensors or Glass Scales diagnostic Section 4.6 or 4.7
Bad Motor Encoder	See Motor diagnostics Section 4.4

3.2.2 Slow Down Axis

The axis slows down and moves at a feedrate that is lower than rapid or than the programmed feedrate.

Do the following Service Codes:

- **Code 33** Software Identification. This is needed if you call SWI Customer Service.
- **Code 100** Axis open loop test. Used to check the maximum feedrate of an axis and if the encoders are counting.
- **Code 129** Set's the maximum allowable arc accuracy error. This applies to arcs only.

Possible Cause	Check This
The maximum allowable Arc Accuracy is set too low.	This value will only slow down the machine during arc moves. The factory default is set at 0.001". Perform Code 129 to check or change this value. See Service Codes section
Incoming AC voltage is inadequate	Perform Code 100. See Service Codes - Section 4.9 and Electrical Section 4.8
Table and Saddle Locks are locked	Make sure the Table and Saddle Locks are unlocked.
Inadequate or no Lubrication to Ballscrews and Way surfaces	Make sure all the Way surfaces are getting proper lubrication. If not, check to make sure that the lube pump is functioning properly. Also check for any pinched or blocked oil lines. See Lubrication Section 4.1.3
X and Y Gibs are not adjusted properly	Check the adjustment of the X and Y Gibs using the X and Y Gib adjustment procedures.
Binding in the Drive Train	Check Repeatability using the Repeatability and Positional Accuracy procedure. Check the torque reading of the Drive Train. Step by step, carefully inspect the Drive Train for any binding. It may be necessary to disassemble and then reassemble the Drive Train. See Mechanical Drive Train (X, Y) Section 4.2
Servo Drive failure	See Servo Drive Section 4.5
Motor failure	See Motor Section 4.4

3.2.3 Axis Will Not Jog

The system powers up but will not respond to the jog command.

Do the following Service Codes and procedures:

- **Code 33** Software Identification. This is needed if you call SWI Customer Service.
- **Code 100** Axis open loop test. Used to check the maximum feedrate of an axis and if the encoders are counting.

Possible Cause	Check This
Improper Boot-up	Shut down the system and wait 10 seconds before rebooting
E-Stop is pressed in	Check E-Stop. Especially if both axes will not jog
Servo Drive failure	Especially, if only one axis will not jog; See Servo Driver Section 4.5
Shorted motor	See Motor Section 4.4
Poor cable or wiring connections	See Electrical Connection Section 2.12
Computer/Pendant failed	See Computer/Pendant diagnostics Section 4.3

3.2.4 Axis Motor Motion Is Not Smooth

While under motor power, the motion is not smooth. The motion appears to be "rough" or jerky".

Do the following Service Codes and procedures:

- **Code 33** Software Identification. This is needed if you call SWI Customer Service.
- **Code 11** Measure's the backlash in the system. Only used on machines with Dual Feedback systems.
- **Code 12** Feed Forward Constant. High feed forward constants will cause an unstable servo system.
- **Code 127** Measure's the backlash in the system. Only used on machines with single feedback. Also used on SMX3 Z axis.
- **Code 128** Enter backlash compensation. Also used on SMX3 Z axis.
-
- **Code 100** Axis open loop test. Used to check the maximum feedrate of an axis and if the encoders are counting.

Possible Cause	Check This
X and Y Gibs are not adjusted properly	Check the adjustment of the X and Y Gibs using the X and Y Gib adjustment procedures.
TRAK Sensor or Glass Scale problem	Make sure that the Sensor or Glass Scale is installed correctly according to the Sensor or Glass Scale Installation procedures. Check for any loose brackets or misalignment etc. Also, check to make sure the Sensor or Glass Scale assemblies are functioning correctly. See TRAK Sensors or Glass Scales Section 4.6 & 4.7
Calibration or Backlash problem	Recalibrate the machine. Reset the Backlash. Check Repeatability and Positional Accuracy. See Calibration & Backlash Constants section.
Binding in the Drive Train	Check Repeatability using the Repeatability and Positional Accuracy procedure. Check the torque reading of the Drive Train. Step by step, carefully inspect the Drive Train for any binding. It may be necessary to disassemble and then reassemble the Drive Train. See Mechanical Drive Train (X, Y) Section 4.2

3.2.5 Vibration in Motion

While axis is moving there is vibration or noise coming from the X or Y-axis.

Do the following Service Codes and procedures:

- **Code 11** Measure's the backlash in the system. Only used on machines with Dual Feedback systems.
- **Code 12** Feed Forward Constant. High feed forward constants will cause an unstable servo system.
- **Code 127** Measure's the backlash in the system. Only used on machines with no Dual Feedback.
- **Code 128** Enter backlash compensation.
- **Code 123** Calibrate.

Possible Cause	Check This
Too much backlash entered in Code 128 or Code 11.	Recheck the machines backlash.
Inadequate or no Lubrication to Ballscrews and Way surfaces	Make sure all the Way surfaces are getting proper lubrication. If not, check to make sure that the lube pump is functioning properly. Also check for any pinched or blocked oil lines. See Lubrication section
X and Y Gibs are not adjusted properly	Check the adjustment of the X and Y Gibs using the X and Y Gib adjustment procedures.
Gibs not making good contact.	Pull gibs out and mark with a blue die to check where the gibs are making contact. It is recommended that the gibs uniformly contact at least 80% of the surface.
Binding or looseness in the Drive Train	Check Repeatability using the Repeatability and Positional Accuracy procedure. Check the torque reading of the Drive Train. Step by step, carefully inspect the Drive Train for any binding or looseness. It may be necessary to disassemble and then reassemble the Drive Train. See Mechanical Drive Train (X, Y) Section 4.2
Axis Motor belt too tight.	Loosen belt.
Misalignment of ball screw	See Mechanical Drive Train (X, Y) Section 4.2

3.2.6 Searching Axis

The handwheels are slowly turning back and forth when the servos are engaged. Several thousandths of motion are observed on the vernier dial and the frequency is one cycle every couple of seconds.

Do the following Service Code and procedures:

- **Code 11** Measures backlash in system. (Used only with glass scales and sensors.)
- **Code 12** Sets a feed forward power constant to drive axis motors.
- **Code 128** Backlash compensation on single feedback machines.

Possible Cause	Check This
Most often causes by excess backlash compensation	Use code 127. Check physical backlash in system and re-enter in code 128. Run code 11 on dual feedback machines
High feed forward values	Check ball screw torque. Typical values should be between 10 to 15 in-lbs.
Excessive friction in the sliding ways	Lubrication, gib adjustments, gib locks. See Machine Tool & Setup - Section 4.1
Looseness in the drive train	Especially the tightness of the drive assembly. See Mechanical Drive Train (X, Y) - Section 4.2

3.3 Problems Relating to the Operation of the Control

3.3.1 Display Blanks

The display is completely blank.

Possible Cause	Check This
Screen saver has been activated	Press any key to turn back on. All LED keys on pendant will blink when the screen saver is on. Press any key to deactivate. Hitting this key will not activate any feature on the control.
The system has shut down	Turn the power switch off, check the computer/ pendant fuses and cable connections. See Electrical Section 4.8
Poor cable connection from Computer Module to LCD (Liquid Crystal Display)	Double-check the connection from the computer module to the LCD.
Fuse blown in pendant	Remove fuse and check continuity
Computer/Pendant failed	See Computer/Pendant Section 4.3

3.3.2 Bad Picture on the Display

The display has strange characters, horizontal bars or other unfamiliar images, or the display continually rolls.

Possible Cause	Check This
Computer/Pendant failed	See Computer/Pendant Section 4.3

3.3.3 Keyboard Lockup

The screen display is normal, but the system will not respond to key presses.

Do the following Service Codes and procedures:

- **Code 81** To check if the pendant keys are working properly, press each key. If a key is working properly, the corresponding key on the screen will light up in yellow. The pendant will also beep.

Possible Cause	Check This
Voltage drop/spike has occurred	Shut down the system and wait 10 seconds to reboot the system.
Remote Stop-Go (RSG) switch has a short (if connected)	Remove the RSG. Turn the system off and then on again. If the problem goes away and then re-appears when the RSG is plugged-in, replace the RSG.
Computer/Pendant failed	See Computer/Pendant Section 4.3

3.3.4 Fault X or Y

The program run or jogging operation is interrupted with a Fault Message on the display.

Do the following Service Codes and procedures:

- **Code 33** Software Identification. This is needed if you call SWI Customer Service.

- **Code 11** Measure's the backlash in the system. Only used on machines with Dual Feedback systems.
- **Code 12** Feed Forward Constant.
- **Code 100** Axis open loop test. Used to check the maximum feedrate of an axis and if the encoders are counting.

Possible Cause	Check This
Cable connection problems	Check umbilical 1 and 2. Check #1 for X and Y-axis problems and #2 for the Z-axis.
Table and Saddle Locks are locked	Make sure the Table and Saddle Locks are unlocked. High torque on any axis may cause faulting problems during alignment routine.
X and Y Gibs are adjusted extremely tight	Check the adjustment of the X and Y Gibs using the X and Y Gib adjustment procedures. See X and Y Gib Adjustments Section 5.2.1
Excessive friction in the slideways	See Machine Tool & Setup Section 4.1
Binding or looseness in the Drive Train	See Mechanical Drive Train (X, Y) Section 4.2
Incoming electrical power	Incoming voltage. See Electrical Section 4.8
Measurement system not functioning properly	See Section 4.6 or 4.7
Servo Drive failure	See Servo Driver - Section 4.5
Motor failure	See Motor diagnostics, Section 4.4
Computer/Pendant failure	See Computer/Pendant diagnostics, Section 4.3

3.3.5 Problems Reading the Floppy Disk; Programs Not Saved Properly; The floppy drive will not read or write programs from a disk.

Possible Cause	Check This
Improper Boot-up	Shut down the system and wait 10 seconds before rebooting
Floppy Disk failure	The Floppy Disk may be bad. See if the Floppy Disk can be read by a Personal Computer. Does the green light on the floppy drive come on when you access the disk? If so, power is getting to the floppy drive. If not check connections of floppy drive inside the computer module. See Computer/Pendant Section 4.3 for more information.

3.3.6 System Will Not Turn On or Boot-Up

Nothing happens when the switch is turned on or the system does not boot-up.

Possible Cause	Check This
110 V line is not plugged in	Check incoming 110 V power source to black electrical cabinet
Pendant On/Off switch is Off.	Check the Pendant On/Off switch
Fuse blown in pendant or electrical cabinet	Remove fuses and check continuity.
Flash Drive failure	When the Computer Module starts the boot-up process, look at the 8th line on the Display Screen. If the Mother Board of the Computer Module is communicating with the Flash Drive you will see "Detecting IDE Primary Master...Scan Disk SDCFB-64". If the Mother Board of the Computer Module is not communicating with the Flash Drive you will see "Detecting IDE Primary Master ... None". Also, check the wiring connection between the Flash Drive and the Mother Board. See Computer/Pendant diagnostics Section 4.3
Computer/Pendant has failed	See Computer/Pendant diagnostics Section 4.3

3.3.7 System Reboots by Itself

During operation, the screen suddenly blanks and then shows that the system has begun the boot-up sequence.

Possible Cause	Check This
Interruption of 110 V power to pendant	Using a Voltmeter, check the incoming 110VAC to the pendant.
Poor wiring and cable connections	Check for any loose wiring or cables
Computer/Pendant failed	See Computer/Pendant diagnostics Section 4.3

3.3.8 System Shuts Off

During operation, the system shuts off and will not turn back on.

Possible Cause	Check This
Fuse blown in pendant	Remove fuse and check continuity
Poor wiring and cable connections	Check for any loose wiring. Also, check the 110VAC Power Cable connection from the 110VAC Power Strip to the Pendant. See Electrical Section 4.8
Computer/Pendant has failed	See Computer/Pendant diagnostics Section 4.3

3.3.9 Will Not Hold Calibration

The control will not hold calibration. Go to the "Configuration Values" screen and write down the calibration values for the motor encoders (Encoder) and the position feedback encoders (scales or sensors). The calibration values are written in Hexadecimal. Recalibrate the system and see if the values change. Turn the system off and on and see if the values are held.

Do the following service codes and procedures:

- **Code 33** Software Identification. This is needed if you call SWI Customer Service.
- **Code 313** Configuration Values
- **Code 123** Calibration Mode.

Possible Cause	Check This
Configuration file corrupt	Load default configuration by going to code 313
Not saving Calibration values	Replace Computer/Pendant module. See Computer/Pendant

If calibration factors are being saved, but the measurements are not repeating or are not accurate:

- See Measurements Are Not Repeating
- See Measurements Are Not Accurate

3.3.10 Auxiliary Functions Not Working (Option on 3 Axis Machines Only)

The Auxiliary Functions will not turn on or off at the programmed times. There are 3 Auxiliary Functions:

1. Activates or deactivates a "110VAC Receptacle" typically used for a coolant pump or solenoid for mister.
2. Sends an electrical signal to rotate the turret on a "Haas Indexer".
3. Turns the "Spindle Off" at the end of a programmed event. (Note: This function is not available for retrofits.).

In order to run the above auxiliary functions in run mode, the accessory key on the front of the pendant must be in the AUTO mode. Press and hold to activate AUTO mode.

All of the auxiliary function signals are carried down to the cable breakout box through umbilical #2. Each function then has its own relay inside this box. If one of these relays fail then these features will not work.

Do the following service code and procedures:

- **Code 33** Software Identification. This is needed if you call SWI Customer Service.

Possible Cause	Check This
Bad 110VAC "Coolant or solenoid" receptacle fuse	Check if the fuse light indicator next to the plug is lit. Verify that the fuses are good or bad by checking the resistance of the fuses using an Ohmmeter.
Poor cable connections	Check all the cable connections on the cable breakout box, Coolant Pump, and Air Solenoid (Located on the Air Regulator). In particular, check umbilical # 2 cable, which carries the auxiliary function signals.
Faulty "Indexer" connector	Check for continuity between pins 3 and 4, when the output of the Haas Indexer connector is activated.
Bad cable breakout box	Check 110 V power coming out of the AC E-stop port with the E-stop in the out position. This will cause the spindle to not run.

3.3.11 E-Stop Error

The E-Stop turns the power off to the axis and spindle motors. This is done by stopping 110V power from reaching the cable breakout box through the use of a relay in the pendant.

Once power reaches the cable breakout box it distributes power to the axis motors, auxiliary functions and 110V power to the spindle contactor for non-spindle control machines. If power does not reach the cable breakout box then none of these functions will work.

Spindle Control Electrical Box

A 5-volt logic signal is sent to the spindle control board, which energizes a relay that enables the AC drive.

Non Spindle Control Electrical Box

110V Power reaches the electrical box through the AC E-stop cable. It is used to energize the spindle motor contactor. If this contactor is not energized the spindle will not turn on. See Figure 19.

If the E-Stop button is depressed, and no message is displayed on the screen, then either the E-Stop button or the Computer Module is at fault.

Possible Cause	Check This
Faulty E-Stop switch	Check the cable connections from the computer module to the E-Stop switch. Check the E-Stop switch for functionality.
Bad Computer Module	Does 110 V power come out of the cable breakout box power cord on the pendant? If yes, and the screen has an E-stop message, replace the computer module.

3.3.12 Limit Switch Error - Optional

Limit switches are installed on the table, saddle, and ram to prevent serious damage to the machine in the event of a crash. In the event a limit switch is triggered, a limit switch error will appear on the screen.

Critical Error 52: Servo Error
X-axis Limit Switch
Correct the fault condition and continue.

To return the machine to its normal state of operation, perform the following procedure:

1. Use mechanical handwheels on X and Y to move switch off of trigger. For the Z-axis, manually lift the arm on the trigger to return the limit switch to its normal position. Then jog the ram up or down as necessary.
2. Press the "Mode" or "Return" key to reset the control
3. Press the "DRO" key to enable the machine to once again jog.

Possible Cause	Check This
Limit switch jumpers in cable breakout box are making poor contact.	Remove and reseat jumpers.
Limit Switches are triggered	Reset the Limit Switches using the procedures described above.
Poor Limit Switch Cable connection	Check for any pins that are loose, pushed in, or bent. Verify that there is a good connection between the cables on the cable breakout box.
Limit Switch failure Try this Switch 2 limit switch cables on the cable breakout box.	Does the limit switch problem move to the other axis? If it does then the switch is most likely the problem. If it stays with the original axis then it could be the cable breakout box.

3.4 Problem with the Measurements

3.4.1 X, Y and Z-Axis Measurements Do Not Repeat

With a dial indicator mounted to the bottom of the spindle, touch off a fixed surface either in the X or Y-axis direction and then set the DRO equal to 0. Crank away several inches and then touch off again at the same place. If the reading has not returned to 0 on the DRO, zero the display and repeat the procedure. If the measurement does not repeat, you have a repeatability problem that must be resolved.

Test for accumulative error by moving the axis a number of times to see if the error gradually grows by a small amount. If so, it may be caused by a misaligned sensor or scale. If the error abruptly changes by a large amount, it may be caused by a bad encoder.

Expected repeatability numbers should be 0.0005" or less.

Do the following service codes and procedures:

- **Code 304** Toggle X sensor/glass scale on/off
- **Code 305** Toggle Y sensor/glass scale on/off

Possible Cause	Check This
Machine Tool & Setup problem	Check for any looseness in the setup (Tool, Tool holder, Part, Vise, or Fixture). Make sure there is sufficient contact between the tool holder and the spindle. See Machine Tool & Setup Section 4.1
X and Y Gibs are loose	Check the adjustment of the X and Y Gibs using the X and Y Gib adjustment procedures.
TRAK Sensor or Glass Scale problem	Make sure that the Sensor or Glass Scale is installed correctly according to the Sensor or Glass Scale Installation procedures. Check for any loose brackets or misalignment etc. Also, check to make sure the Sensor or Glass Scale assemblies are functioning correctly. Use service codes 304 for X and 305 for Y to turn off the suspect encoder. Does problem still exist after turning it off?

Possible Cause	Check This
X and Y-axis Drive Trains are loose	Check Repeatability using the Repeatability and Positional Accuracy procedure. Step by step, carefully inspect the Drive Train for any looseness. It may be necessary to disassemble and then reassemble the Drive Train. See Mechanical Drive Train (X, Y) Section 4.2
Encoder Disk or Reader Head on motor are loose	Swap the motor in question with a known good motor. For example, swap the X-axis motor with the Y-axis motor. If the symptom stays with the motor in question, then replace the motor. If not, then the motor is not at fault and something else is causing the problem.
Spindle and/or Quill are loose	Use a Dial Indicator and check for side-to-side movement between the Spindle and the Head. Next, check for side-to-side movement between the Quill and the Head. There should be no more than 0.0003" of side-to-side movement. Make sure that there is a few thousandths gap between the Spindle Collar and the Quill after tightening.
Head bolts are loose	Tighten Ram bolts

3.4.2 X, Y, and Z-Axis Measurements Are Not Accurate

Measurements repeat, but with a dial indicator mounted to the bottom the spindle, traversing the length of a gage block or some other measurement standard, the measurement is not accurate.

Possible Cause	Do This
The Calibration is incorrect	Recalibrate the machine. See Calibration & Backlash Constants
Incorrect backlash values	If the machine does not repeat bi-directionally check the backlash on the axis in question. See Section 5.2.2.

3.4.3 The DRO Is Not Counting

The DRO for one axis is not counting when an axis is moved. Often times if this is the case the axis will fault. See section on faulting.

Do the following Service Codes:

- **Code 33** Software Identification. This is needed if you call SWI Customer Service.
- **Code 100** Axis open loop test. Used to check the maximum feedrate of an axis and if the encoders are counting.
- **Code 304 & 305** Turns off X and Y sensor or scale.

Possible Cause	Check This
Motor Encoder not counting	See Motor diagnostics (not applicable with Glass Scale option). Single feedback only.
Glass Scale or Sensor Failure	Does axis now count? If so, replace scale or sensor.
Computer/Pendant failure	See Computer/Pendant diagnostics

3.4.4 X, Y, and Z-Axis DRO Counting in Wrong Direction

The DRO is counting in the wrong direction.

The positive directions for each axis are:

- **X-axis** – Table moves to the left.
- **Y-axis** – Saddle moves toward the front of the machine.
- **Z-axis** – Quill moves up.

Do the following service code and procedures:

- **Code 33** Software Identification. This is needed if you call SWI Customer Service.
- **Code 313** Check the line that specifies the product.

If the product does not match the machine then the machine ID key will need to be replaced.

3.4.5 X, Y, & Z-Axis Electric Handwheels Count in Wrong Direction

The Electric Handwheels count in the wrong direction.
The positive directions for each Electric Handwheel are:

- **X-axis** - Electric Handwheel turns clockwise.
- **Y-axis** - Electric Handwheel turns counterclockwise.

Do the following service code and procedures:

- **Code 308** Reverse X-axis Handwheel Direction.
- **Code 309** Reverse Y-axis Handwheel Direction.

3.5 Problems with the Machine Tool

3.5.1 Spindle Stalls or Turns-Off During Machining

During machining, the spindle turns off and loses power. First check incoming voltage and connections.

Possible Cause	Check This
Machine Tool and Setup problem	Check the type of material being cut, type and size of cutting tool, RPM, and Feed rate. Also check the condition of the cutter to verify that the cutter is not dull. See Machine Tool & Setup Section 4.1
Drive Belt in the head is slipping	Check the alignment, condition, and tension of the Drive Belt.
Cut more than the machine is capable	Check width and depth of cut
Insufficient voltage, excessive amp load	Check incoming power. Check overload setting.

3.5.1.1 Spindle Stalls or Turns-Off During Machining (For Machine with the Optional Spindle Control Drive)

During machining, the spindle turns off and loses power. First check incoming voltage and connections.

Possible Cause	Check This
Machine Tool and Setup problem	Check the type of material being cut, type and size of cutting tool, RPM, and Feed rate. Also check the condition of the cutter to verify that the cutter is not dull. See Machine Tool & Setup Section 4.1
Drive Belt in the head is slipping	Check the alignment, condition, and tension of the Drive Belt.
Cut more than the machine is capable	Check width and depth of cut
Spindle Drive Thermal Overload Relay has tripped	IOUT - Current Out (located on the Spindle Drive) cannot exceed 12.75A for K2/K3 and 21A for K4 for more than a few minutes. When the Overload Relay is tripped, an "oL1" error occurs shutting off the Spindle Drive. The harder the Spindle Motor works trying to make heavy cuts, the more current the Spindle Motor utilizes. This can be caused by a cut so large that it exceeds the machine capability, or a problem with the spindle motor or AC drive.
Spindle Drive parameters are not correct	May need to re-download the Spindle Drive parameters. Contact Customer Service for assistance.
Spindle Run Command not reaching AC Drive	Verify Spindle Run LED is on Spindle Control Board.

3.5.2 Spindle Motor Hums or Will Not Run

If the spindle will not run, you must ensure that 110V power is reaching the spindle motor contactors in the electrics box. Check your 110V power across terminals wire 3 and ground. If power is not reaching the electrical cabinet but is reaching the cable breakout box, most likely a relay has failed in the cable breakout box. The cable breakout box will need to be replaced. This relay is in series with the 110V power in the E-stop circuit. See Section 3.3.11. If power has reached the electrical box, use the schematic in Section 4.8 to see how the power is routed.

If the spindle motor makes a constant humming noise during operation, check the 3-phase power to the machine by checking line to line.

Possible Cause	Check This
Wrong voltage	Check the 220V/440V voltage to the machine
Poor wiring connections	Check all the wiring connections to the electric's box.
Defective cables or poor cable connections	Check all cable connections
Spindle Motor is bad	Check the resistance of the Spindle Motor windings on the Spindle Motor between L1 & L2, L2 & L3, and L1 & L3, using an Ohmmeter. The resistance should range from ".7 to 1.2 Ohm" for

	the K2 and K3, and ".5 to .9 OHM" for the K4. If the Ohmmeter reads "0 Ohms" or "OL", then replace Spindle Motor. Next, check the resistance between L1 & Ground, L2 & Ground, and L3 & Ground, using an Ohmmeter. The resistance should read "OL". If not then replace Spindle Motor.
Spindle will not run because 110 V power is not reaching the spindle contactor	Check 110 V coming out of the AC e-stop port on the cable breakout box. Relay failure in cable breakout box. Replace cable breakout box.

3.5.2.1 Spindle Motor Hums or Will Not Run (for machine with the optional Spindle Control Drive)

The spindle motor makes a constant humming noise during operation or will not turn on.

Note: machines can only be wired for 220 volts. 440 volts will ruin electrical components in the machine. These components will not be covered under warranty.

Possible Cause	Check This
Wrong voltage	Check the voltage to the machine before and after the Spindle Drive with a Voltmeter. Also, check the voltage to the Spindle Drive (L1, L2, and L3).
Poor wiring connections	Check all the wiring connections to the Spindle Drive and Spindle Motor. See Electrical Connection
Improper wiring/jumper configuration on the Spindle Motor	Check to make sure that the Spindle Motor has the correct wiring/jumper configuration for 220VAC. See Electrical wiring section.
Spindle Drive may be in "Local Mode" and cannot be run from the Pendant	On the Spindle Drive, push the "DSPL" button until "LO/RE" lights up. Use the "Up" and "Down" arrow keys to choose between "Lo"- Local (Run Spindle Motor from Spindle Drive) or "rE" - Remote (Run Spindle Motor from the Pendant).
Spindle Motor is bad	Check the resistance of the Spindle Motor windings on the Spindle Motor between L1 & L2, L2 & L3, and L1 & L3, using an Ohmmeter. The resistance should range from "1.0 Ohms" to "1.5 Ohms" for K2/K3 and ".5 Ohms" to ".9 Ohms" for K4. If the Ohmmeter reads "0 Ohms" or "OL", then replace Spindle Motor. Next, check the resistance between L1 & Ground, L2 & Ground, and L3 & Ground, using an Ohmmeter. The resistance should read "OL". If not then replace Spindle Motor.
Spindle Drive contains incorrect parameters and is not programmed correctly	Contact customer service.
Spindle Enable Signal not reaching AC Drive	Verify LED on Spindle Control Board is on.
Forward/Reverse Switch is bad or Spindle Control Board	Verify Forward or Reverse LED on Spindle Control Board is lit.

3.5.3 Spindle Runs Backwards

The spindle motor runs in the opposite direction. The spindle will run in opposite directions from high to low gear.

Possible Cause	Check This
3-Phase wires backwards	Need to switch any 2 of the 3 wires either coming into the machine or motor. Note: For machine fitted with the optional Spindle Control, switch any 2 of the 3 wires either coming out of the AC Drive (T1, T2 & T3) or going into the Spindle Motor (U, V & W). Warning: Be sure to shut off all power to the machine before attempting to switch any wires.

3.5.4 Head Noise

Head noise pertains to any unusual noises coming from the head under load and no load situations. Most often head noise will only be noticeable under load situations. It is important to try to distinguish between problems with components in the head versus problems caused by the setup or tooling being used on a particular job. Use the table below to try to pinpoint the possible cause. Also try to pinpoint the noise by seeing if it exists in high, low or neutral. For example, if the noise is evident in neutral then this eliminates the spindle bearings.

Non Spindle Control Drive Machines

Possible Cause	Check This
Machine setup or tooling problem	If the noise is most evident under load (cutting situations) then it is important to look at setup and tooling being used. Ask the following questions. Is the cutter dull? Is the tool loose in the holder? Am I taking a bigger cut then is possible on the machine? Is the part moving in the vice? Am I using realistic speeds and feeds? Any one of these can have a significant impact.
Upper spindle bearing is worn out.	Remove the upper bearing plate above the spindle. This will unload the bearing. If the noise goes away then this bearing should be replaced.
Verify nosepiece is tight on bottom of spindle.	To check if the nosepiece is bottomed out try to insert a piece of paper in between the nosepiece and the quill. If a piece of paper does fit then this may be the problem. Before tightening or loosening the nosepiece make sure to loosen the setscrew that holds it in place.
Spindle bearings are worn out	This is categorized by a high pitch sound and is most evident at high RPM's. It should also cause chatter under load. Replace the spindle if this is the case. See spindle replacement in Section 5.

Machines with spindle control drive

Possible Cause	Check This
Machine setup or tooling problem	If the noise is most evident under load (cutting situations) then it is important to look at setup and tooling being used. Ask the following questions. Is the cutter dull? Is the tool loose in the holder? Am I taking a bigger cut then is possible on the machine? Is the part moving in the vice? Am I using realistic speeds and feeds? Any one of these can have a significant impact.
Upper spindle bearing is worn out.	Remove the upper bearing plate above the spindle. This will unload the bearing. If the noise goes away then this bearing should be replaced.
Verify nosepiece is tight on bottom of spindle.	To check if the nosepiece is bottomed out try to insert a piece of paper in between the nosepiece and the quill. If a piece of paper does fit then this may be the problem. Before tightening or loosening the nosepiece make sure to loosen the setscrew that holds it in place.
Spindle bearings are worn out	This is categorized by a high pitch sound and is most evident at high RPM's. It should also cause chatter under load. Replace the spindle if this is the case. See spindle replacement in Section 5.
The belt is not lined up with the grooves on the pulleys.	Make sure the 10-ribs on the belt are lined up with the 10-grooves on the 2-pulleys. If the belt is frayed then replace the belt.

4.0 Diagnostics

This section explains the diagnostic procedures used to isolate service problems.

4.1 The Machine Tool & Set-Up

4.1.1 The Milling Machine Checklist

The following is a quick reference for the types of problems that may arise if problems are noticed in these areas.

Problems With:	Can Contribute To:	Most Suspect When (and why):
Spindle bearings See Spindle Replacement	Noisy head Parts incorrect Circles out of round	Older machines, machines that are pushed hard
Lubrication system	Premature wear of ball screws, wear surfaces. Faulting Poor finish	New installations (may not be hooked up or line sheared)
Inadequate lubrication habits	Premature wear of ball screws, wear surfaces Poor finish Faulting	New installations (more motion than the machinist is used to with a manual mill) Lubricate machine every morning before use.
Gib locks - on X and Y axis	If locked can lead to axis faults.	*Note: when using the CNC to machine, never tighten the gib locks!*
X and Y gibs loose See Gib Adjustment - Section 5.2.1	Taper on straight Y moves Poor finish Circle out of round	When machine hasn't been serviced in a long while.
Gibs too tight	Not getting to position, does not repeat, axis faults Poor finish	N/A
Gibs floating	Not getting to position, does not repeat, axis faults Poor finish	Contact area of gibs. May need to be scraped. Very old machines may not have any more adjustments on gib. A new gib will need to be fit on the machine.
Gibs defective - bowed, scarred	Excess play when gib is checked side to side	Inadequate gib contact
Way surfaces pocked, scarred, or excessively worn	Poor finish Out of round circles Faulting	Inadequate lubrication
Machine not level Weight not distributed evenly on all four screws See Leveling procedures	Parts incorrect Machine geometry off, i.e. tram.	New installation or heavy crash. Relocation of mill.
Head out of tram See Tramming Head - Section 5.2.3	Leaves uneven surfaces on bottom of pockets.	Machine not level

4.1.2 A Special Word About X & Y Gibs

The slideway surfaces are vital to the performance of the bed mill.

Gibs should be:

- flat
- free of twist
- free of burrs
- free of blockages in the oil passages and channels

Defective or scarred gibs must be replaced. Shimming of gibs may not yield acceptable results.

It is good machining practice to avoid the use of shop air to clean the chips off a machine. This risks blowing chips into the sliding way surfaces and compromising the performance of the machine.

Gibs that are not adjusted correctly will affect the performance of the machine. It will lead to positioning and repeatability problems. The gibs should be adjusted at least twice a year.

See Gib Adjustments Section 5.2.1.

4.1.3 Lubrication

Lubrication is one of the single, most important maintenance issues and plays a key role in assuring the performance and durability of the Knee mill. At the beginning of each day manually supply oil to the way surfaces.

Lack of lubrication can lead to a variety of problems with your machine motion due to increased friction in the sliding ways. This increased friction may lead to part inaccuracies and decreased life expectancies of your ball screws and way surfaces.

4.1.4 Machining Set-Up

The machining set-up itself is always something that can greatly influence the performance of the your mill. The following are some things to keep in mind.

Problems With	Can Contribute To:
Feed and Speeds (spindle rpm) See below	Poor finish Machine chatter Excessive speeds and feeds can break cutting tools or wear tools prematurely.
Tooling Using the wrong cutter for an application Entering the wrong size diameter and programming with tool compensation.	Poor finish Parts incorrect size
Cutting too deep	Part dimensions incorrect Driving and cutting forces cause deflections, since no material is totally rigid Machine chatter
No coolant	Poor finish, decrease the life of the cutter

4.1.4.1 Spindle Speeds

Spindle speeds are influenced by a number of variables:

- Material
- Rigidity of the Machine Setup
- Coolant
- Cutter type, material and diameter
- Cutting Depth

As a general rule:

- Lower spindle speeds are used to machine hard or tough material or where heavy cuts are taken.
- Higher spindle speeds are used to machine softer materials in order to achieve better surface finishes. Higher speeds also apply when using small diameter cutters for light cuts on frail work pieces and delicate setups.

Note: Cutter diameter greatly affects spindle speeds. The larger the diameter, the lower the spindle speed.

4.1.4.2 Feedrates

Factors that affect feedrates:

- Depth and width of cut
- Design or type of cutter
- Sharpness of the cutter
- Workpiece material
- Type of finish or accuracy required
- Climb or conventional milling

If a fine finish is required, reduce the feed rather than increase the spindle speed. Cutters are dulled by higher spindle speeds rather than high feedrates.

4.2 The Mechanical Drive Train (X, Y)

Indications:

- Troubleshooting instructions indicate that the drive train is potentially the problem and other (more easily checked variables) have been exhausted.
- Roughness, looseness, tightness or jamming movement in the table or saddle.

1. Check for machine considerations, especially gib locks and gib adjustments. See Gib Adjustments section
2. Check the torque of the axis in three places (both ends and center of ball screw) along the length of the ball screw. The torque should be within 2 or 3 in-lbs across the length of the ball screw. If it is not, chances are the ball screw is misaligned. A misaligned ball screw can lead to parts being out of round and servo problems at low feedrates. A bad ball screw can also cause high torque, although this is highly unlikely. See Sections 4.2.1 and 4.2.2 for more information.

The following steps take you in logical sequence through the assemblies for the knee mills. For drawings of these assemblies see Figures 31 and 32 in Section 5. These instructions break the machine down from fully assembled and point out the areas to look at specifically.

3. Check that the belt is properly tightened. A loose belt can lead to excessive backlash compensation values on motor encoder only machines.
4. Check that the nut that tightens up against the ball screw pulley is tight. If this is loose the pulley may not run true on the ball screw.
5. Check that the tapered sleeve that seats the pulley has not clamped to the ball screw prematurely. It should be seated firmly against the pulley. Tightening the nut may not have ensured this. Also make sure the pulley is keyed to the ball screw.
6. Ensure that the screws that hold the bearing housing in place to the bracket are not loose.
7. Ensure that the Clamp Nut is secured. The following applies to the clamp nut:
   - When loosening, make sure to back out the 10-32 screw from the clamp nut.
   - When tightening, snug the 10-32 screw so the clamp goes onto the ball screw thread with some drag. Thread it onto the ball screw and torque the clamp nut to 50 ft/lbs and then tighten the screw down.
8. Take out the angular contact bearings and inspect them. They should roll smoothly and be lightly greased. If not, replace them. When putting the bearings back into the housing make sure to put them in correctly. Failure to do this will cause problems. The thin race of each bearing should be facing inward toward the spacer ring.

   Note: the bearing housing and spacer ring are matched sets - keep them together.
9. Check the ball screw mounting to the yoke. Make sure the SHCS are tight.
10. Inspect the ball screw, ball nut and yoke for the potential problems shown in the chart on the next page.

CAUTION!
Unlike a lead screw, do not unscrew the ball screw from its nut. This will destroy the ball screw!

Potential Problem:	Check By:
Bad ball screw	• Visually inspecting the ball nut - if the nylon seal is broken or deformed, if contamination has visibly entered the ball nut or if balls are out of the ball nut, replace the ball screw. • Cranking the ball screw through a significant part of its travel. If it jams, feels loose or has rough spots, replace the ball screw. • Using the dial indicator on a vertical flat of the ball screw to check for backlash between the ball screw and ball nut.

Potential Problem:	Check By:
Ball nut not tightened to the yoke	• Inspection for space between the head of the bolt and the ball nut i.e. the retaining bolt has bottomed out in its thread and is not securing the ball nut to the yoke properly.
Yoke loose in the saddle	• Inspection for any motion of the yoke or looseness in the Yoke mounting screws.
Oil lines sheared	• Visual inspection.
Oil line blockage	• Pump the oil and ensure that it flows evenly to the ways and ball screw.
Ball screws not aligned properly	• Measure from the ball screw to the back of the saddle on both sides of the yoke (the table must be removed). The measurements must be within ±.005" end to end. See above explanations.

Note: Ball screws are inspected throughout their entire travel for backlash and consistent torque. A ball screw should be good for millions of inches of travel if installed properly. Do not be too quick to replace a ball screw if there is insufficient indication that it is bad; this will just be a costly delay to resolving the real problem.

4.2.1 Keys to Ball Screw Alignment

- **X-axis** – there are 3 components that can cause misalignment: the yoke, the left side bearing housing bracket, and the right side bearing housing.
- **Yoke** – the yoke is aligned at the factory and pinned in place. It is aligned to within +/-0.0005" with a precise alignment tool. The yoke most likely is not causing the problem. If this were the problem you would need to remove the pins and align the X ball screw with the back of the saddle. Drill new holes and pin the yoke in place. The Y-axis ball screw bore is machined perpendicular to the X bore. If the X-axis is aligned the Y-axis will also be aligned.
- **Left side table bearing housing** – this is most likely the cause of the misalignment. To align the bracket and bearing housing, move them as close to the yoke as possible. Loosen the bracket bolts and bearing housing bolts and then retighten. This should allow the bearing housing to align itself up with the yoke.
- **Right side table bearing housing** – once again move the bearing housing as close to the yoke as possible. Loosen the bearing housing and retighten. This should allow the bracket to align itself. If you do not move the table toward the yoke the ball screw will tend to bend down slightly and cause misalignment.
- **Y-axis** – the only component that can cause a misalignment problem is the motor mounting bracket. To align this bracket, move the saddle as close to the front of the machine as possible. Loosen the bracket and then retighten it. Once again moving the saddle forward allows the yoke to be as close to the bearing housing as possible.

4.3 Computer/Pendant Diagnostics

The pendant consists of 2 separate modules: the computer module, and LCD screen/enclosure.

In general, the pendant/computer module is best diagnosed by eliminating all other possible alternatives. The following table lists some problems and what these problems can lead to.

Possible problems	Can lead to
Poor cable connections	There are 4 cable connections (6 spindle control) to the left side of the pendant. Make sure all cables are properly fastened.
Pendant locks up	Press the E-stop button and see if lock up clears if not then do the following: Turn the pendant off, wait at least 30 seconds, and turn it back on and check to see if the malfunction has been reset.
No voltage to RSG port	RSG will not work – should be 5 DC volts present Check with a voltmeter.
Low voltage to flash drive or slave board.	Can cause the system to lock up and the flash drive to act abnormally. Check voltage to power cable at flash drive module with voltmeter. It should be 4.8 DC volts and above. Lower values than this can cause problems.
Flash disk failure	If the flash disk fails, the system will not boot up or operate. It will need to be replaced. All programs and machine configurations will be lost. Make sure to back up your flash disk from time to time.
Floppy disk failure	Will not allow user to save or pull up programs from a floppy disk. Can the floppy drive format a disk? See Section 4.3.1.
LCD backlight burns out	Check all cable connections to LCD, distribution board and computer module. Make sure the power is turned off before doing so.
Faulty E-stop switch	It can be stuck open or closed (pressed). If it is stuck closed the pendant will need to be replaced because the user will have no way to get rid of the message. If it is open it will allow the machine to still operate but it will be unsafe for the user. The pendant will still need to be replaced.
Overlay failure (keys on pendant)	Certain buttons on overlay do not work. Do code 81 to verify each key beeps.
Low voltage to pendant or current spikes	1 amp fuse in pendant blows. Pendant will not turn on.

4.3.1 Checking Floppy Drive by Formatting a Disk

1. Find a new disk and install in floppy drive.
2. Install keyboard into middle port.
3. Press CTRL ESC to get to start menu.
4. Press R for run.
5. Type Format a: - press enter.
6. If the format works your disk drive is working. If format does not work, reboot control and see if it now works. If it does not work replace the computer module.
7. Press ALT ESC to get back to PT4 software.

4.4 Motor Diagnostics

The Motor subsystem is comprised of 3 parts: The Motor Encoder and the Motor and Servo Driver. The motors are powered by 110 VAC voltage. The servo driver is also an integral part of servo system, which is discussed in detail in the next section.

WARNING!

Do not work with the motors unless the power is disconnected from the machine. The motors are run by 110 VAC. There is possibility of death by electrocution!

Rarely do both the X and Y motor/servo systems fail at the same time and in the same way. So, if your problem is occurring on both axes, its source is probably somewhere else.

4.4.1 Cable Connections

Check the motor cable connections on the cable breakout box. Verify there are no pushed in pins on the connector.

4.4.2 To Check the Motor Encoders

If the motor encoder inside the motor has failed or is not reading the machine will fault out on that axis. Do the following to verify this problem:

Motor encoder only machines – run Service Codes 100 or 131. This will display on the DRO if the motor encoder is counting. If the axis does not count, the encoder is not counting. This means either the encoder or the cable is the problem. Visually check the cable for any problems. If the encoder has failed the motor must be replaced.

Motor encoder and secondary feedback machines – run Service Codes 100 or 131. Both the motor encoder and sensor or glass scale encoder should count on the DRO screen. The motor value should be displayed under the Z-axis and the sensor or glass scale under the X or Y-axis depending on which axis you are doing.

4.4.3 Encoder Counts to Pendant

Before replacing the motor due to a bad motor encoder it is a good idea to check the cables that take those signals back to the pendant. If these signals are not getting back to the pendant then the axis will fault. Check the following cable connections.

- Umbilical #1 and #2 at the cable breakout box
- Umbilical #1 and #2 at the pendant
- Umbilical #1 carries the X and Y-axis signals and Umbilical #2 carries the Z signals.

4.4.4 Moving Problem from One Axis to Another

Another way to troubleshoot a problem with a particular axis is to swap parts from 1 axis to another to see if the problem moves. If the problem moves then that component is faulty. See the example below.

Symptom – X Axis will not move and faults

This particular problem can happen because of any of following reasons: bad motor, servo driver, or computer module. In some cases it is not obvious which component is causing the problem. This example will help us pinpoint the problem through a trial and error process.

Let's assume we have narrowed it down to the servo or electrical systems and the Y-axis has no problems. Lets also assume it is not an obvious problem like a loose connection.

Swap these components	Results
Physically switch the X and Y motors	Has problem moved to Y-axis? If yes, replace motor. If no, the motor is not the problem.

4.5 Servo Driver

Note: the Servo Driver is located in the black box on the side of each motor.

Indications:

- Problems moving just one axis, including hard turning in one or both directions.

Servo Types:

- X and Y servos are identical

Objective:

- Isolate the problem to the particular Servo Driver

Steps:

1. Turn off and unplug the system.

WARNING!

Do not work with the Servo Driver unless the power is disconnected from the machine. There is possibility of death by electrocution!

2. Physically swap the servo module from the axis that is not working to one that is.

Note: To avoid pulling the wires out of the connector, use the loop to pull the connector from the Servo Driver.

If the problem moves to the other axis and clears up from the original axis, replace the Servo Driver.

4.6 Glass Scales

Glass scales are used on the X and Y-axis for secondary feedback. They are optional on the TRAK Knee mill machines. The Z glass scale comes standard with the machine.

4.6.1 Alignment of scales

- X Axis - The X-axis scale must be aligned within 0.005" in the up and down direction over the length of the scale for proper operation. Misalignment can cause the scale to not read in the certain areas of the scale that are not aligned with the reader head. If this happens, the axis will mostly likely fault out in this area. Also make sure the mounting hardware for the reader head is tight. Loose hardware can cause excess backlash when reversing direction.

  To align the scale, place a 0.001" indicator on the bed ways and on top of the scale extrusion. Move the table along its full travel from one end to another to verify it is aligned. If the scale is misaligned loosen the 2 screws at either end to shift the scale up or down as needed. You will also need to loosen the center support bracket to allow the scale to pivot.

- **Y Axis** - The Y-axis must be aligned in the up and down direction and must be parallel to the Y-axis way surface. Both surfaces must be aligned to within 0.005". Failure to align the scale properly could cause the same problems as mentioned above. Mount your 0.001" indicator on the saddle and move the Y-axis back and forth along its travel.

- **Z Axis** – The Z scale must be aligned parallel with the quill. Make sure the gap on the readerhead is consistent along the length of travel. Align the scale within 0.005" up and down.

See Figure 28 in Section 5 for an illustration of the Z glass scales.

4.6.2 Measurements Do Not Repeat

1. Determine if the error in repeatability is random or accumulating:

   - Mount a dial indicator in the quill.

- Touch off a fixed point on the table and set the DRO to 0.
- Traverse away approximately 6 inches.
- Return the touch off again.
- Write down the reading on the DRO.
- Do not Re-zero the DRO, traverse away and return several times.
- Write down the DRO readings

Random error will be unpredictable and give scattered readings, adding and/or subtracting the error after each traverse with no pattern. See Step 2.

Accumulating error will add roughly the same amount to the reading after each traverse. See Step 3.

2. For random error, look for problems in the set-up of the glass scale that have resulted in a loss of rigidity. Common sources of random error include:

   - Loose scale mounting hardware.
   - Loose reader head.
   - Very loose motion of the table or saddle.
   - Loose cable connection

3. Accumulating error is commonly the result of:

   - Scale out of parallel to the axis travel.
   - Dirt or chip on the glass scale.
   - Broken glass.

4.7 TRAK Sensors

TRAK Sensors are used on the X and Y-axis for secondary feedback. They are optional on the TRAK SMX knee mill machines. The following section talks about some of the common symptoms associated with a problem sensor and how to isolate or fix the problem.

Common symptoms

- Faulting Axis
- The DRO measurements do not repeat
- The DRO measurements are not accurate

Objectives:

- To determine if the TRAK Sensor is bad and needs to be replaced.
- To determine if there is a problem with the sensor set-up

4.7.1 Faulting Axis

If a sensor has stop reading and you try to move an axis, the axis will run away and fault. Our control uses the counts from the sensor and motor when reading position. If either one of these signals is not working our system will fault.

1. The first thing that can be done to see if the sensor is at fault is to turn off the sensor on the axis in question. This will allow the system to run only on the motor encoders. If the fault continues then the sensor was not the problem. Turn the sensor back on. See the service code section for a codes needed to turn the sensors on and off. Also, run code 100.

2. The next thing to do is to visually inspect the sensor and base to determine if there has been a crash. A damaged base will usually have crinkles in the small, spring plates on the front and back.
3. Next make sure the sensor is preloaded correctly against the running surface. There is a setscrew on the base that allows for adjustment.
4. If no outward signs of damage are present, remove the sensor from its base, and inspect the wheel for damage and wear.

   If the wheel is worn smooth in the center, replace the sensor.

Note: Sensors should not wear smooth for many years of normal operation.

5. If the sensor looks normal, it is probably OK and there is a mechanical obstruction somewhere in the set-up. Look for the following possible problems:
   - Broken sensor base
   - Broken bracket
   - Sensor tilted too much (so that the wheel is not engaging the running surface)
   - Sensor chip scraper has doubled back and is pushing the wheel away from the running surface
   - Sensor chip scraper is defective or has worn and is pushing the sensor unevenly

4.7.2 Measurements Do Not Repeat

1. Determine if the error in repeatability is random or accumulating:
   - Mount a dial indicator in the quill
   - Touch off a fixed point on the table and set the DRO to 0.
   - Traverse away approximately 6 inches
   - Return and touch off again
   - Write down the reading on the DRO.
   - Do not re-zero the DRO, traverse away and return several times
   - Write down the DRO readings

   Random error will be unpredictable and give scattered readings, adding and/or subtracting the error after each traverse with no pattern. See Step 2.

   Accumulating error will add roughly the same amount to the reading after each traverse. See Step 3.
2. For random error, look for problems in the set-up of the TRAK Sensor that have resulted in a loss of rigidity. Common sources of random error include:
   - broken base
   - broken bracket
   - loose puller screws
   - loose run bar
   - very loose motion of the table or saddle
   - loose clamp screw

3. Accumulating error is almost always the result of the wheel not traveling in a path parallel to the motion of the axis. This causes the wheel to skip at certain regular points in its travel.
   - Inspect the base to determine if it has been damaged. A damaged base will usually have crinkles in the small, triangle-shaped plates on the front and back.
   - Use a bubble level or an indicator to adjust the puller screws so that the base is parallel to the running surface.
   - Inspect that the sensor is not cocked so that the case contacts the running surface.
   - Inspect the wheel for chips that are adhered or for gouges.

4.8 Electrical

4.8.1 Checking A/C Voltage

This procedure tests for the 115V power for the control.

- Use a Voltmeter, reading A/C volts.
- Acceptable range is 100V to 130V.

Note: systems running consistently close to the low values may have problems when normal voltage fluctuations push the voltage out of the acceptable range.

Test the following in the order presented:

Problems Here:	May Indicate:
1. The wall outlet.	• Fuse blown in the shop electrical panel. • Incoming service from local utility is bad. Call the electric company.
2. The control power cord from the wall. Check the end that goes to the electrics box.	• Power cord defective.
3. Check the top fuse on the electrical cabinet. It should be an 8-amp fuse.	• If this is blown then power will not reach the 4 outlets on the electrical box.
3. Check the 110-power cord to the pendant.	• Power cord defective

4.8.2 Checking Fuses

CAUTION!
Turn off power before removing and replacing

There are 4 fuses to check in the system. There are 2 in the pendant and 2 in the electrical cabinet, and one on the breakout box. The top fuse in the electrical cabinet is 8 amps and fuses power to the pendant. The bottom fuse is 5 amps and fuses power to the auxiliary 1, auxiliary 2 and lube pump outlets. The 2 fuses in the pendant are 1 amp and 12 amps. The 12-amp fuses the cable breakout box, and the 1 amp the pendant.

If you have the auxiliary function option then there is 1 more fuse to check on the cable breakout box for the coolant or mister option.

To check fuses:

1. Use a Volt/Ohmmeter; select "OHM".
2. Remove the fuse completely from the pendant, electrics box or cable breakout box.
3. Place a lead of the meter on each end of the fuse.

- A good fuse reads 0 (zero) or close to it.
- A bad fuse reads Open or Infinity.

4.8.3 Cable Breakout Box Connections

This module is located on the back side of the machine. It consists of 3 motor connections, 3 limit switch connections, 3 encoder connections and an E-stop connection.

Machines with an auxiliary function option have 2 more outlets. A 110 V outlet for a coolant pump or air solenoid and an indexer outlet.

The coolant pump signal and indexer signal comes down from umbilical #2.

4.8.4 Cable Connections

The TRAK knee mill machines use 10+ cables to communicate between systems. It is often the case that what appears to be the failure of an electrical component is actually attributable to a poor connection.

Indications:

- Control problems, chronic or intermittent.
- Motor problems
- Measurement problems.

Explanation:

1. Turn off and ***unplug*** the system from the wall.

CAUTION!
Do not plug and unplug connectors with the system power on. This may cause damage to the connector board and harm to the technician.

2. Visually inspect the connections for excessive debris, moisture, or obvious damage.
3. Carefully clean any chips away from the connectors.
4. One-by-one, take out each connector and then plug them back in. Do the same at the computer/display.
5. Make sure to tighten up the screws on each of the connectors.

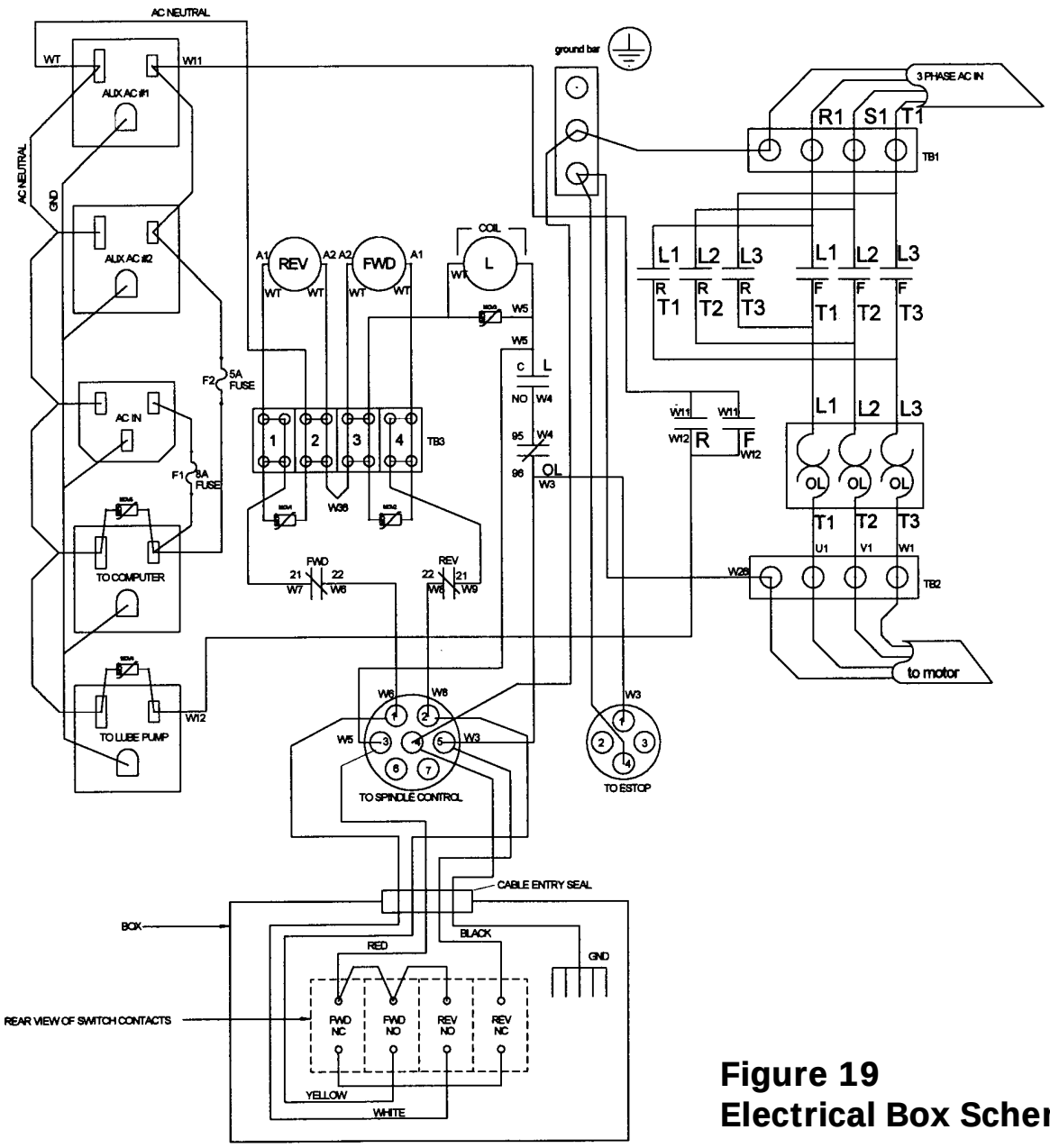

Figure 19
Electrical Box Schematic

4.8.5 Spindle Control Electrical Box

The spindle control electrical box is made up of the following main components:

1. AC drive – used to control the spindle motor.
2. 4 output 110 volt outlets – 1 outlet is used to power the pendant, 1 is used to power the lube pump and is turned on based on the spindle being on, 2 additional outlets.

3. 2 braking resistors – used to brake the spindle motor. The mechanical brake should not be used to brake the spindle. To verify the resistors are good, measure the resistance across B1 and B2 of the AC drive. For 3 HP machines it should read 60 ohms and for 5 HP machines it should read 32 ohms. Values lower or higher than this could be one or both resistors are bad.
4. Relay – used to turn on and off the lube pump and spindle motor fan.
5. Spindle control PCB board - controls the auxiliary signals from the pendant to the AC drive and electrical outlets. The following explains the LED lights on the spindle control board. There are (2) 10 LED segments on the board. Not all of the LEDs are used. See figure 21 for an illustration.

1st 10 LED Segment

4. LED labeled Gear 1 – this light should be on whenever the machine is in low gear. LEDs labeled Gear 2 thru Gear 4 are not used.
5. LED labeled SPD-FAULT – this light will be on whenever the AC drive is in a fault condition, which includes an E-stop message from the pendant.
6. LED labeled SPD-RUN – this light should be on whenever the spindle is on.
7. LED labeled SPD-ENABLE – this light should be on whenever you are in DRO, tool setup and RUN mode.

2nd 10 LED Segment

1. LED labeled E-STOP OUT – this light should be on whenever the E-stop is in the out position. When the E-stop is pressed, this light should go off.
2. LED labeled LATCH RELAY – this light should be on when the spindle is running or if the spindle is not running and the fwd/rev switch is in the off position when in DRO, tool setup or RUN mode. Note – if spindle won't turn on and the spindle is enabled and the e-stop is out, then either the fwd/rev switch is bad or the spindle control board is bad.
3. LED labeled TAP MODE – light should be on whenever you are not tapping. Light will be off when in the tap event. Not applicable to 2-axis knee mills or retrofits.
4. LED labeled TAP REVERSE – this light will be on when the spindle changes direction at the bottom of a tap event and back off after the spindle changes direction once outside of the tap event. Not applicable to 2-axis knee mills or retrofits.
5. LED labeled REV-RELAY – when fwd/rev switch is in reverse this light will be on. Note – this does not mean necessarily that the spindle will be running this direction.
6. LED labeled FWD-RELAY – when fwd/rev switch is in forward this light will be on. Note – this does not mean necessarily that the spindle will be running this direction.
7. LED labeled Z-LIMIT PLUS – this light will be on only when the Z-axis plus limit switch is triggered. This only applies to a 3rd axis product.
8. LED labeled Z-LIMIT MINUS – this light will be on only when the Z-axis minus limit switch is triggered. This only applies to a 3rd axis product.

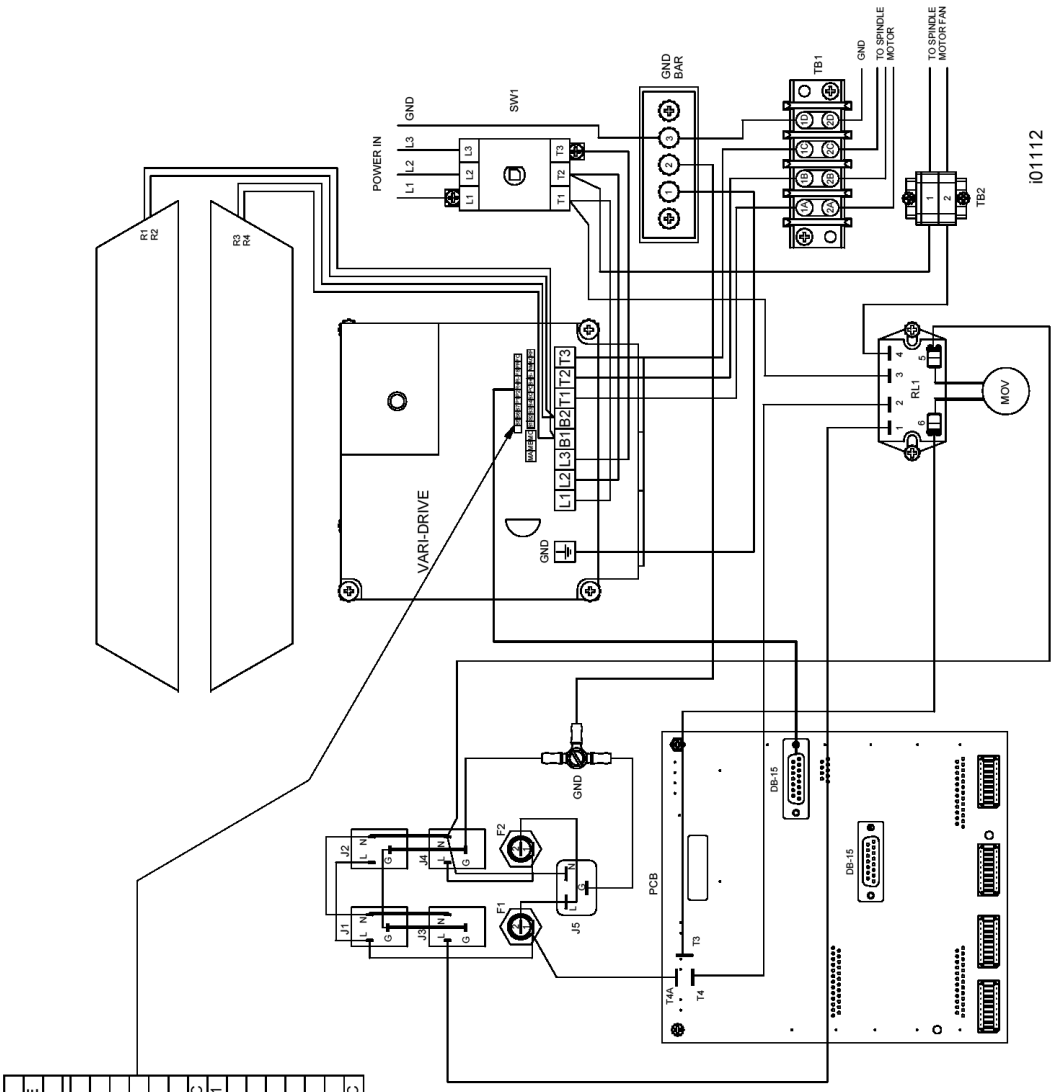

TABLE 1		
ITEM 17 PIN #	FUNCTION	SPINDLE PIN
1	SPD FWD	S1
2	SPD REV	S2
3	SPD E-STOP	S3
4	TAP MODE	S5
5	SPD RESET	S4
6	SPD GND	SC
7	A GND	FC OR AC
8	DAC OUT	FR OR A1
9	GND	MC
10	GND	PC
11	FAULT FDB	MA
12	RUN FDB EN	P1
13	-	
14	-	
15	A GND	FC OR AC

Figure 20
Schematic Diagram of Spindle Control Option

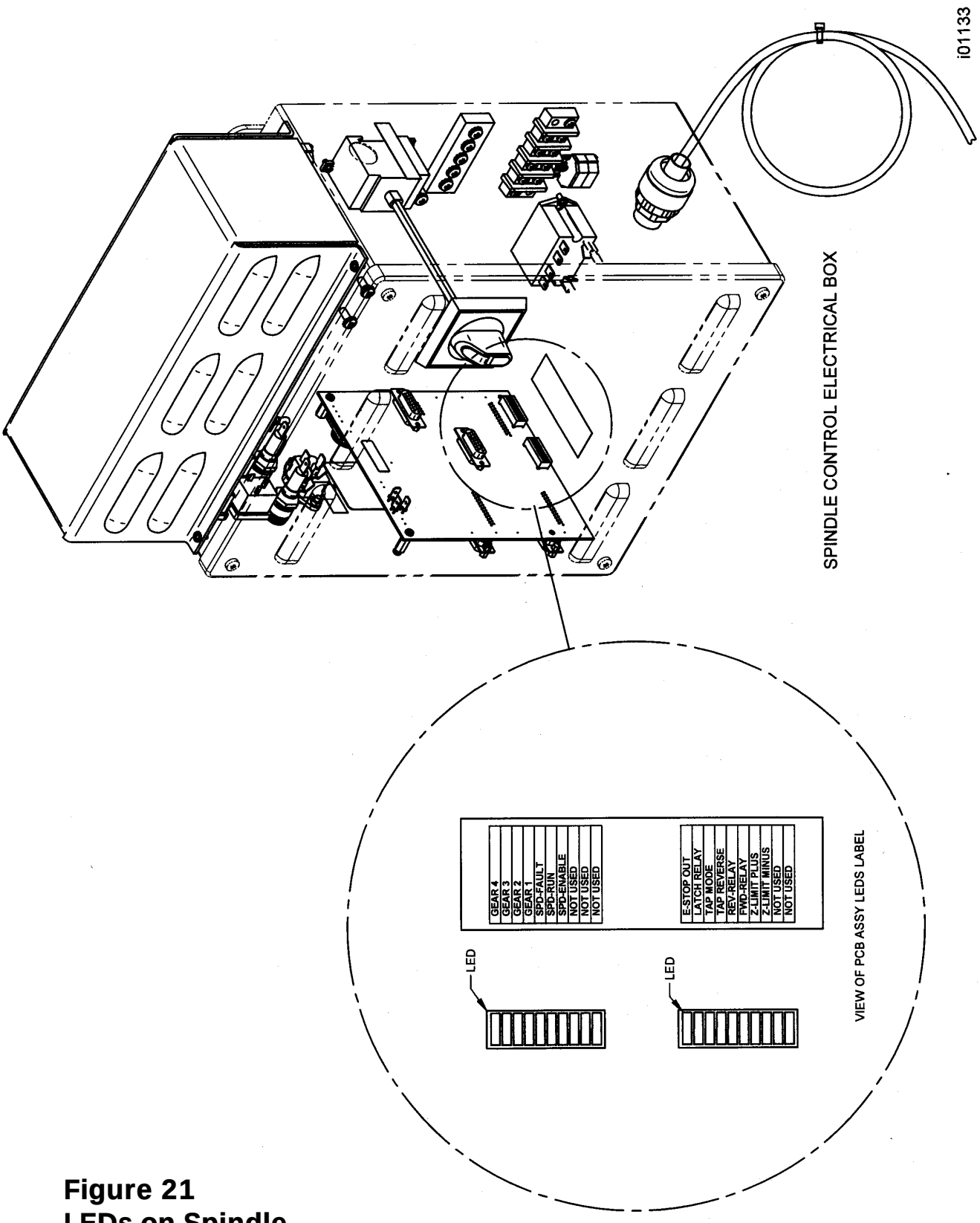

Figure 21
LEDs on Spindle Control Board

4.9 Service Codes

Service codes are broken down into the 4 following categories: software, machine setup, diagnostics and user options/defaults.

All Service Codes are accessed in the SET-UP Mode by pressing the soft key for "SERV CODES". The service codes can be found under one of the headings listed on the main screen. Press the heading you want to access the code in question. If you know code # you want press the CODE # softkey and it will take you directly to the code in question. Press CODE #, enter the number you want, press SET.

4.9.1 Software Codes

The following codes pertain to software functions in the control. To get to any of these codes go to Service Codes, press "A" and press the code you wish to view.

Note: If you are working with the SWI Customer Service Group, write the values down for Code 33 or Code 313. These values will be valuable for troubleshooting.

4.9.1.1 CODE 33: Software ID

The Code 33 is the software identification procedure. The two types of software in the control include:

- **Software Version** - the version of the system you have installed
- **Firmware Version** - the version of firmware software that is responsible for control to servo interface.
- **Converter Version** – the version of software that is responsible for converters and options.
- **Operation System Version** – shows the version of the XP Operating System.

4.9.1.2 CODE 141: Load Configuration file from external drive

This code allows you to load your configuration file from the floppy disk or external drive to your hard drive. The configuration file consists of items such as calibration and backlash constants. This code is used when a computer module or hard drive has been replaced.

4.9.1.3 CODE 142: Save Configuration file to an external drive

This code allows you to save your configuration file to a floppy disk or external drive. The configuration file consists of items such as calibration and backlash constants. This code is used when a computer module or hard drive needs to be replaced. This stores the configuration file from the hard drive to the floppy disk. It is a good idea to do this code after the machine is initially setup so these values can be saved and used in the future. If the computer or hard drive fails, then you will not have the ability to save the configuration file and the machine will need to be re-setup when the computer or hard drive is replaced.

Note: All machines will have a copy of the configuration file in the back of the electric's cabinet.

4.9.1.4 CODE 313: Display Configuration File

This code displays the configuration file. This file contains pertinent information about the machine. The file will look similar to the following. If the file becomes corrupt you can load default values by pressing the F4 softkey.

Product = KNEE2X (displays machine ID key of machine)
Motor encoder calibration constants X=610.0711 Y=610.0812 Z=610.0678
Secondary feedback calibration constants X=3302.6122 Y=3302.5955 Z=3302.5877

(These numbers above are typical numbers for the calibration constants, the numbers for secondary feedback are default numbers, which means no calibration has been done, or the machine does not have secondary feedback)
Arc accuracy – 0.001"
Secondary feedback – 0, 1, 2 or 3
(0 = off, 1 = X on only, 2 = Y on only, 3 = XY both on)

Code 11 values	X = 0.002	Y = 0.001"	
Code 128	X=0.001"	Y=0.0014"	Z=0.0016"
Code 12 (+)	X=000005	Y=000006	Z=000006
(-)	X=000005	Y=000005	Z=000006
Code 100 (+)	X=210.5	Y=208.9	Z=200.1
(-)	X=207.1	Y=208.4	Z=203.6

4.9.1.5 CODE 316: Update Master Software

Load upgrade disk in floppy drive or add software to an external drive and press this service code. New software will automatically download and control will reboot. Please perform alignment routine afterwards.

4.9.1.6 CODE 317: Update Slave Software

Load upgrade disk in floppy drive or add software to an external drive and press this service code. New software will automatically download and control will reboot. Please perform alignment routine afterwards.

4.9.1.7 CODE 318: Activate Converters or Options

See programming and operating manual.

4.9.2 Machine Set-up Codes

The following codes are used primarily when setting up a new machine. To get to any of these codes go to Service Codes, press "B" and press the code you wish to view.

4.9.2.1 CODE 11: Hysteresis

Note: This code is use only for systems with Sensors or Glass Scales on the table and saddle.

The Code 11 service routine checks the readings of the motor encoder against the sensor encoder. It is a measurement of how much motor motion is necessary to create table or saddle motion. This test helps us to look at two things:

- Play: How much backlash must be taken up when motion is reversed.
- Friction: How much the mechanical components must be "torqued up" in order to break the friction and create motion.

The Code 11 procedure is very useful and will help in diagnosing all types of motion and performance problems.

1. Position the table and saddle in the center of travel. *Note: You will lose your DRO position reference.*
2. Go into the Service Codes and input Code 11.
3. The system will run the checking routine automatically and then display the values in the position readout.

Explanation:

As an overall measure of the system hysteresis, we are looking for the X and Y values to be less than .004". A value greater than this indicates a problem with either excessive friction or play that may affect the finish or accuracy of machined parts.

4.9.2.2 CODE 12: Feed Forward Constant

The Code 12 procedure helps the control "learn" the friction characteristics of the machine by sending a graduated series of motor signals and observing the results. The process takes less than 30 seconds to run. It is both a diagnostic routine that displays values, and a routine that sets the parameters of the control for the particular machine.

The Code 12 is used for diagnosing and resolving:

- Problems with machine motion.
- Machined parts come out bad – especially poor finish.

Note: Code 12 routine will set the parameters for the particular machine and its particular situation. If the machine changes its friction characteristic, the Feed Forward Constant should change too, or the system will not servo properly. Whenever gibs are adjusted or a heavy workpiece has been added to the table, you should run a Code 12. When the heavy workpiece is removed, Code 12 should be run again.

1. Position the table and addle in the center of travel. *Note: You will lose your DRO position reference.*
2. Go into the Service Codes and input the Code 12.
3. Press Auto
4. The system will run the routine automatically and then display values on the position readout.

Explanation

Typical values should be between 4.04 and 11.11 are considered normal for each axis. Higher values indicate excessive friction in the system. Lower values indicate a loose system and may mean a gib adjustment is necessary. Value 4.04 means the friction is a factor of 4 in one direction, and 4 in the other direction. The values should be within 3 or 4 of each other in both directions. A value of 6.08 would still be considered normal.

On S products, do not equate Code 12 values to torque on ballscrew. Measure friction in system with an in-lb torque wrench.

The feed forward gain can be adjusted manually by pressing the manual button. Choose the axis you would like to change and then enter values in the positive and negative direction to adjust. Adjusting the gain can help solve circularity problems. Default values can be set by pressing the Reset button. The manual feature should only be used in extreme cases where the AUTO routine did not solve the problem. Manual adjusts above 12 may lead to servo related problems.

4.9.2.3 CODE 100: Axis Open Loop Test

Code 100 procedure is used to diagnose problems with the configuration of the system, the encoders and incoming A/C voltage.

CAUTION!

During this procedure, the designated axis will be given a command to move at maximum speed for 1 second in the direction you choose. Avoid crashes by making sure the quill is out of the way and by starting with the table and saddle centered. MAKE SURE THAT NO ONE IS STANDING IN THE WAY OF THE TABLE OR SADDLE!

Note: You will lose the DRO reference position.

This procedure is to be run for each axis that is servo-driven, and for both the plus and minus direction for each axis.

1. Center the table and saddle and raise the head. Make sure the gib locks are released.
2. On the Pendant display, go into the Service Codes and input the Code 100.
3. The conversation line will say: "SELECT AXIS". Input the axis. Either X, Y or Z.
4. In the conversation line it will say "WHICH DIRECTION? PLUS".
   - If you want to run in the plus direction, press INC SET.
   - If you want to run in the minus direction, press +/-, then INC SET
5. In the conversation line it will say "PRESS GO". Press Go after you are sure that the machine will not crash in the direction and axis that you have specified.
6. Afterward the screen will display values next to the DRO position axes. The table below assumes machine has secondary feedback. Machines with motor encoders only will display the reading next to the axis in question.

Your input	Display	Data displayed.
X +	X	table encoder reading
	Y	nothing (should be 0)
	Z	Motor encoder reading
	Feedrate	the maximum feedrate attained
Your input		
X -	X	table encoder reading
	Y	nothing (should be 0)
	Z	Motor encoder reading
	Feedrate	the maximum feedrate attained
Your input		
Y +	X	nothing (should be 0)
	Y	table encoder reading
	Z	Motor encoder reading
	Feedrate	the maximum feedrate attained
Your input		
Y -	X	nothing (should be 0)
	Y	table encoder reading
	Z	Motor encoder reading
	Feedrate	the maximum feedrate attained
Your input		
Z +	X	nothing (should be 0)
	Y	nothing (should be 0)
	Z	motor encoder reading
	Feedrate	the maximum feedrate attained
Your input		
Z -	X	nothing (should be 0)
	Y	nothing (should be 0)
	Z	motor encoder reading
	Feedrate	the maximum feedrate attained

Interpretation of the resulting values displayed:

The values for the encoder displays should be in the range of 3.0000" to 5.0000".

- If the motor encoder and sensor or glass scale reading is not within this value, then the one that is out of specification may be the problem. If one of the encoders is not reading then it will need to be replaced.
- The feedrate should be a minimum of 120 ipm.

- If the feedrate is less than 120 ipm and inconsistent in both directions, check the incoming AC voltage and mechanics of the drive train.

4.9.2.4 CODE 123: Calibration

See Section 5.2.2 for a further explanation of this code.

4.9.2.5 CODE 127 - Set X or Y Backlash Constant

See Section 5.2.2 for a further explanation of this code.

4.9.2.6 CODE 128: Input Backlash Constant

Code 128 allows you to enter the backlash values for each axis. It displays the value after it enters. This code is only used on machines with motor encoders only.

4.9.2.7 Code 304: Toggles X sensor or glass scale on/off

This service code toggles the X sensor or glass scale on or off. It is used to configure the machine and also is a useful tool for troubleshooting. Code 313 (configuration file) displays whether the sensors have been turned on or off. The line labeled secondary feedback explains which sensors or glass scales are turned on. This line can read any one of the following:

0 = sensors or glass scales turned off

1 = X sensor or glass scale turned on only

2 = Y sensor or glass scale turned on only

3 = both X and Y sensor or glass scale turned on

4.9.2.8 Code 305: Toggles Y sensor or glass scale on/off

This service code toggles the Y sensor or glass scale on or off. See Code 304 for further explanation.

4.9.2.9 Code 321: Reverse Y position sensor direction

This service code reverses the direction of the encoder. It may be needed if sensors or glass scales are mounted on different sides of the machine.

4.9.2.10 Code 322: Reverse X position sensor direction

This service code reverses the direction of the encoder. It may be needed if sensors or glass scales are mounted on different sides of the machine.

4.9.2.11 Code 325: Reverse Quill Sensor Direction

This service code reverses the direction of the encoder.

4.9.3 Diagnostic Codes

The following codes are used primarily when diagnosing a problem with the machine. To get to any of these codes go to Service Codes, press "C" and press the code you wish to view.

4.9.3.1 Code 54: Program Continuous Run

This Code runs a program continuously without stopping for SET Z or CHECK Z commands. It is helpful in running a long period to identify an intermittent problem.

1. Prepare a program as you normally would.
2. Press **MODE**, **SET UP**, **"C"**, **Code 54**, **INC SET**. The program run will start automatically.
3. Press **STOP** to stop, and **GO** to continue.

4.9.3.2 Code 81: Keyboard Test

This code is used to check if the keyboard is functioning correctly. It allows you to test each key on the pendant individually. When you press the keys, the corresponding box for that key will highlight on the screen. The pendant will also beep, indicating that the key is working correctly. If one of the keys does not work the pendant assembly may need to be replaced. If none of the keys are working chances are that the computer module will need to be replaced.

4.9.3.3 Code 131: Manual DRO

A manual diagnostic routine to check the motor encoder and table encoders. Turn the X hand wheel to display the encoder readings. This code will display the actual DRO counts and the raw encoder counts.

4.9.3.4 Code 132: Electronic Hand Wheel Test

Turn the X, Y, or Z-axis electronic hand wheel. The display should show movement as the hand wheel is being turned. There should be no skipping and it should count smoothly while the hand wheel is being turned. One revolution of hand wheel should read 0.2000" when in fine mode and 0.800" in course mode

4.9.3.5 Code 314: Toggle test lights 'on' in status line

This code toggles on and off 2 test lights that appear in status line. The top light signifies if the master software is working. If functioning it should flash a green light. The bottom light signifies if the slave firmware is functioning. It will appear orange in run mode when it is processing information. Pressing the mode key will change this orange box to black. The orange box will also change to black when the program you are running reaches the 3rd event from the end of the program. If the firmware is locked up no keys will work. This code is useful for diagnosing intermittent problems with the control locking up.

4.9.3.6 Code 319: Error Log

This code when turned on captures the commands that were sent to the servo system. It includes items such as positioning commands, errors, stop and go commands, etc. It may be helpful for identifying problems between programmed commands and executed commands. To turn on the error log press the F6 softkey. The page forward and backward keys allow you to scroll through the file one page at a time. The data forward and data backward keys allow you to scroll through the file one line at a time. The data bottom key takes you to the bottom of the file and then changes to data top which will take you back to the top. The file will capture data until the file reaches a size of approximately 600 Kb. At this time the file is saved to a backup file and the original file is cleared and data is once again captured. Once again as the file reaches a size of 600 Kb it copies over the previous backup file. From here the user can save the file to the floppy drive or an external drive by following the instructions on the screen. Once this in done it prompts you for which file you want to save to disk. The F1 key saves the current file to disk and the F2 key saves the backup file to disk. To clear the files press the F7 softkey.

4.9.3.7 Code 324: Toggle Simulation Mode

Simulation Mode allows the control to run a program without actually moving the table. It is helpful in diagnosing Computer/display problems.

4.9.4 Operator Defaults/Options Codes

The following codes allow the user to set programming defaults or turn features on or off. To get to any of these codes go to Service Codes, press "D" and press the code you wish to view.

4.9.4.1 Code 66: Default Metric

This code causes the control to turn on in the metric mode.

4.9.4.2 Code 67: Default English

This code causes the control to turn on in the English mode.

4.9.4.3 Code 79: Beeper On

This turns on the beeper to the control keys.

4.9.4.4 Code 80: Beeper Off

This turns off the beeper to the control keys.

4.9.4.5 Code 129: Arc Accuracy

When the SMX control operates at high feedrates it may create small part machining errors as it goes around sharp corners. This exists on all CNC's and is commonly called a "following error." The control is factory preset to allow a maximum following error of 0.001 inch. The feedrate will automatically be adjusted around sharp corners so as to not violate this limit. This code only applies to arcs that are programmed and ones that are created in the tool path to generate the shape you want. This code will not make a difference on mill moves.

You may adjust the maximum following error to a value as small as .0001 inch. However, the smaller the value, the slower the feedrate around corners.

To input a new Following Error use the following procedure:

Follow the instructions on the screen and input the Following Error value (from .0001 to .0100) and press **INC SET**.

5.0 Procedures for Replacements & Maintenance

5.1 Replacements

5.1.1 Servo Motor Replacement

WARNING!
Do not work with the Servo Motors unless the power is disconnected from the machine. The servomotors are run by 110 VAC. There is possibility of death by electrocution!

1. Turn off power to the machine.
2. Each motor is mounted by the use of (4) ¼ - 20 screws. Be careful not to over tighten these bolts and strip the threads.

5.1.2 Servo Driver Replacement

WARNING!
Do not work with the Servo Drivers unless the power is disconnected from the machine. The servo drivers are run by 110 VAC. There is possibility of death by electrocution!

The Servo Driver for each axis is integrated into the servo motor casting.

WARNING!
Always engage (push in) the Emergency Stop switch, turn the ProtoTRAK SM Control off, and disconnect the servo motor/driver cable at the cable breakout box.

1. Press in the Emergency Stop.
2. Remove the servo motor/driver assembly from its mounting bracket.
3. Remove the 10 cap screws that hold the servo driver and its heat sink plate to the motor casting.
4. Disconnect the cable connector. Do not pull on the wires.
5. Reinstall the new servo driver with its heat sink plate. Be certain the gasket properly seals the assembly.
6. Reinstall the motor/driver assembly. Make certain the belt is tight so that there is little play if pinched in the middle.

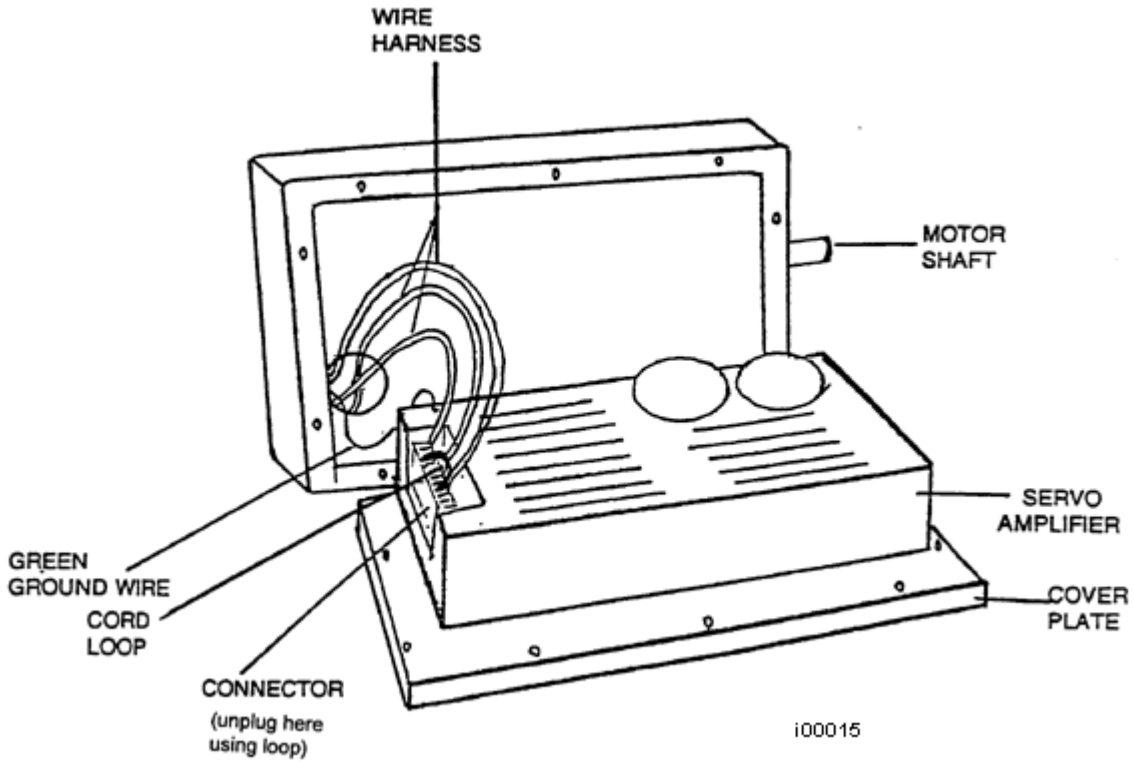

Figure 22

Part #	Description
20201	X, Y or Z Servo Driver

5.1.3 Computer Module and LCD/Enclosure Replacement

1. Turn off power to the machine and control.
2. Unplug all the connectors on the pendant arm side of the pendant.
3. Remove the pendant from the pendant arm by removing the (4) ¼ - 20 x 3/4" SCHS that secure it in place.
4. Place the pendant assembly on a clean and secured table with the display pointing away from you.
5. Remove the (6) 10-32 x 3/8" Pan Phillips Head Screws and (4) 10-32 x 3/8" FHCS securing the computer module to the LCD/enclosure.
6. Pull the computer module a few inches and stop. Pulling the computer module too far will damage the ribbon cables.
7. Now reach from the top and remove the 37-pin LCD cable, 37-pin distribution cable and the 9-pin E/Stop cables. The cables are to stay with the computer module.
8. Now slide the module about ½ way out of the LCD/enclosure.
9. Remove the ground wire from the LCD/enclosure side.
10. Lastly, slide the unit completely out of the LCD/enclosure.
11. Replace computer module or LCD/enclosure.
12. Follow the instructions in reverse order when reinstalling the new computer module or LCD/enclosure.

Make sure that all connectors are properly seated before fastening the unit back in place.

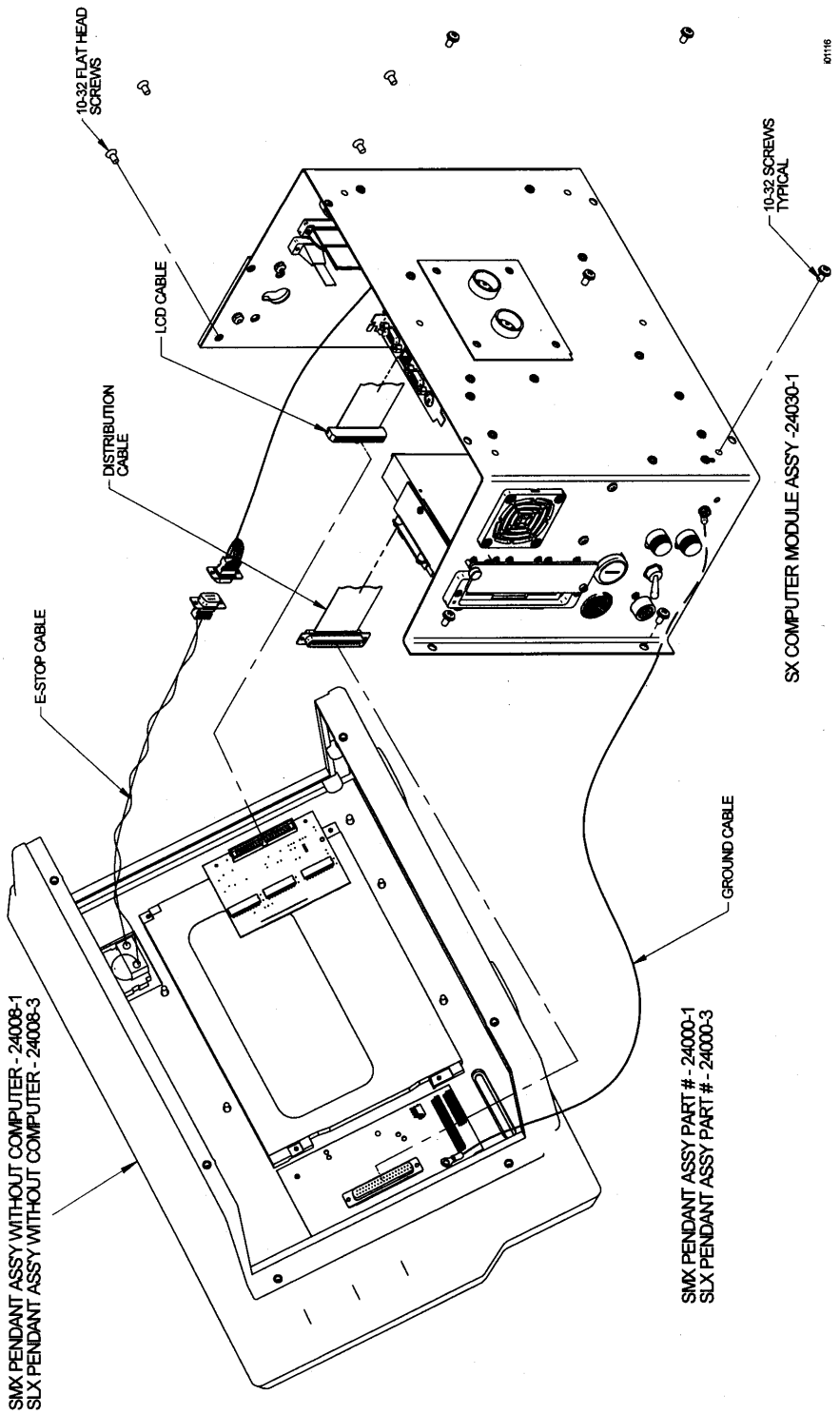
10-32 FLAT HEAD SCREWS
LCD CABLE
DISTRIBUTION CABLE
E-STOP CABLE
10-32 SCREWS TYPICAL
SX COMPUTER MODULE ASSY - 24030-1
GROUND CABLE
SMX PENDANT ASSY WITHOUT COMPUTER - 24008-1
SLX PENDANT ASSY WITHOUT COMPUTER - 24008-3
SMX PENDANT ASSY PART # - 24000-1
SLX PENDANT ASSY PART # - 24000-3

Figure 23
Computer Module & LCD/Enclosure Replacement

5.1.4 System Flash Disk Replacement

1. From the control, go to SETUP, SERV CODES, SECTION A, and then code 142 and save your Configuration file (calibration values, etc.) on a floppy disk or USB drive. Label this disk as "Backup Configuration" and store it for later use.
2. Turn power off to the machine and control.
3. Unplug all the connectors on the pendant arm side of the pendant.
4. Remove the pendant from the pendant arm by removing the (4) ¼-20 x 3/4" SCHS that secure it in place.
5. Place the pendant assembly on a clean and secured table with the display pointing away from you.
6. Remove the (6) 10-32 x 3/8" Pan Phillips Head Screws and (4) 10-32 x 3/8" FHCS securing the computer module to the LCD/enclosure.
7. Pull the computer module a few inches and stop. Pulling the computer module too far will damage the ribbon cables. If need be, remove 4 cables that connect the computer module to the enclosure. Make sure to reattach them securely before re-assembling the pendant.
8. Remove the defective System Flash Disk (located on the back side of the mother board) by pushing the eject button on the flash drive.
9. Firmly insert the replacement System Flash Disk into the drive, making sure that the label with the serial number is pointing towards the motherboard.
10. Secure the computer module back to the LCD/enclosure by following the instructions in reverse order.
11. Make sure that all connectors are properly seated before fastening the unit back in place.
12. Turn power on to the machine and control.
13. When the system boots, you may get a message stating that the system cannot find your configuration file. Clear this message and continue.
14. From the control, go to SETUP, SERV CODES, SECTION A, and then code 33 and verify your software and firmware versions are current.
15. To verify the current version, go to www.southwesternindustries.com, click on support and then Software for current Prototrak CNC's, locate the download for the control.
16. If your software is an older version and does not match the one on the website, follow the instructions for updating your control using a USB thumb drive.
17. Restore the Configuration file saved on your backup configuration disk with service code 141 found in section A of the service code section.
18. If your control was networked prior to this change, you will have to reset your network settings.

CAUTION!

It is a good idea to back up your flash disk from time to time via a network, external drive or floppy disk. If your flash disk needs to be replaced you will loose all of your programs. See your programming manual for instruction on how to do this.

Figure 24
Flask Disk

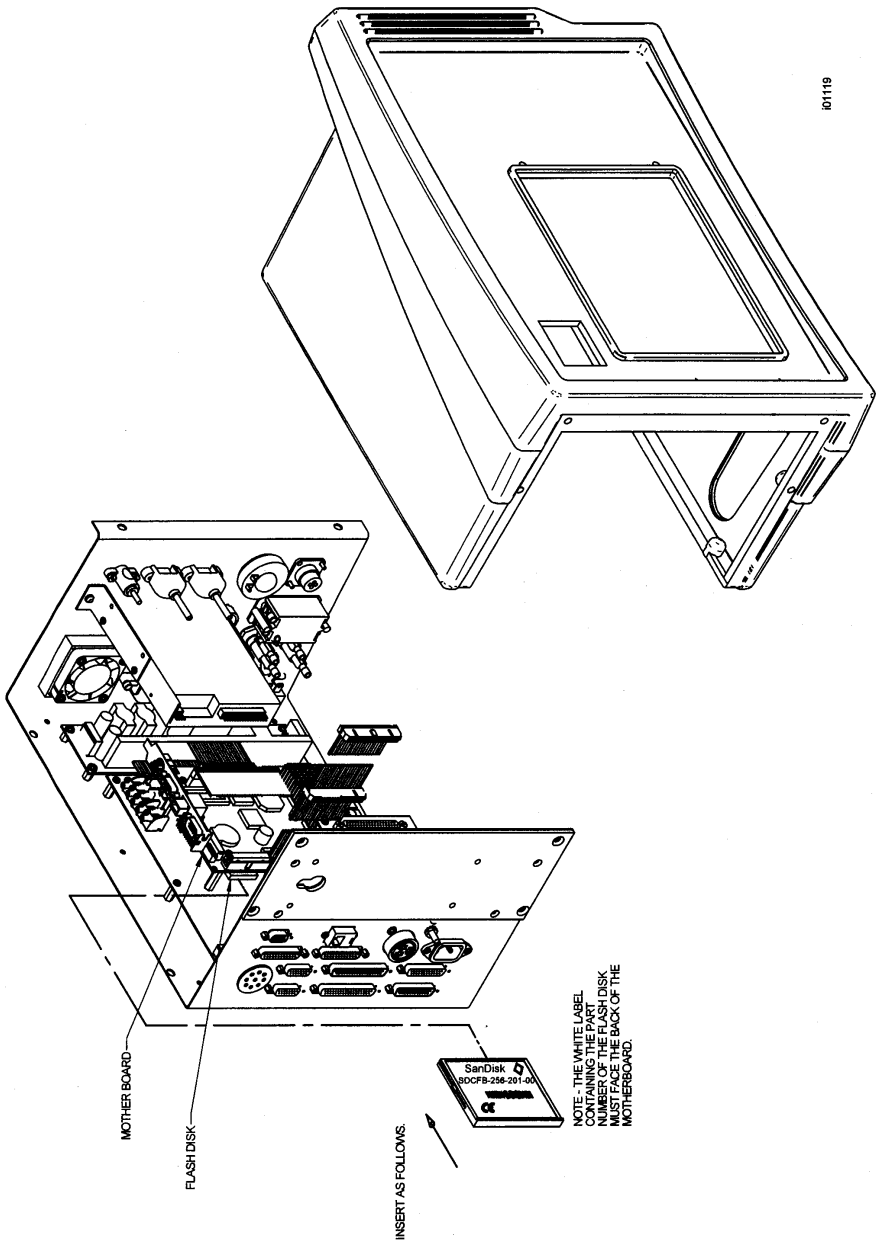
i01119
MOTHER BOARD
FLASH DISK
INSERT AS FOLLOWS.
SanDisk
SDCFB-256-201-00
NOTE - THE WHITE LABEL CONTAINING THE PART NUMBER OF THE FLASH DISK MUST FACE THE BACK OF THE MOTHERBOARD.

Figure 24
Flash Disk Replacement

Flash Disk Parts List

Item	P/N	Description
1	24008-1	PENDANT WITHOUT COMPUTER MODULE
2	24030-1	COMPUTER MODULE
3	25078	FLASH DISK (used on Revision D or later pendant)
	25078-1	FLASH DISK (used on Revision C or earlier pendant)

5.1.5 Cable Routing on Machine

Whenever you replace a cable or reroute a cable it is very important to keep the power cables and logic cables separated from each other. The power cables consist of the (3) 110-volt motor cables and (2) 110-volt power cables for the pendant, and a coolant pump or solenoid power cable. The logic cables are used to carry encoder signals between the cable breakout box and computer module. Mixing of the power and logic cables may cause noise from the power cables to interrupt the signals in the logic cables. This can lead to intermittent axis faults or repeatability problems. See Figure 15 and 16 for a layout of the cable connections.

5.1.6 TRAK Sensor

5.1.6.1 Replacing the M5 Base

See Figures 25 and 26.

1. Remove the sensor by removing the clamp screw and then backing the load screw out a few turns. The sensor should lift off the base easily.
2. Remove the old M5 Base by removing the two 1/4-20 hex head screws that are threaded into the base.
3. Assemble the new base as per Figure 25.
4. Use a bubble level to align the raised bumps on the base with the table for X axis or saddle ways for Y-axis.
5. A dial indicator may be used to align the bumps on the base instead of a bubble level.

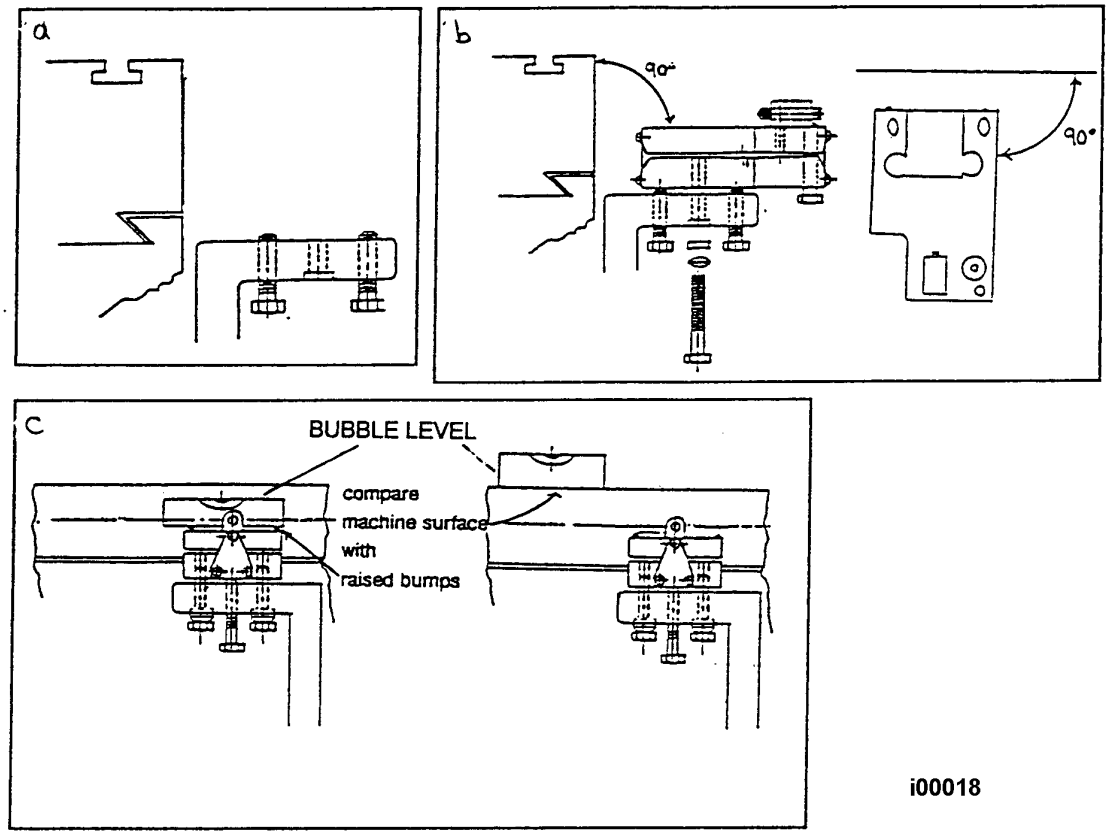

Figure 25
M5 Base Mounting

5.1.6.2 Replacing the TRAK Sensor

1. Remove the old sensor by removing the clamp screw and then backing the load screw out a few turns. The sensor should lift off the base easily.
2. Install the new sensor on the M5 base using the clamp screw.
3. Load the sensor against the running surface (table or run bar) using the load screw. The white lines on the side of the M5 base tell you when it is loaded correctly.

Note: You want to load the gage wheel against the running surface using the flat spring of the M5 base. Do not tighten the clamp screw fully until after loading the sensor.

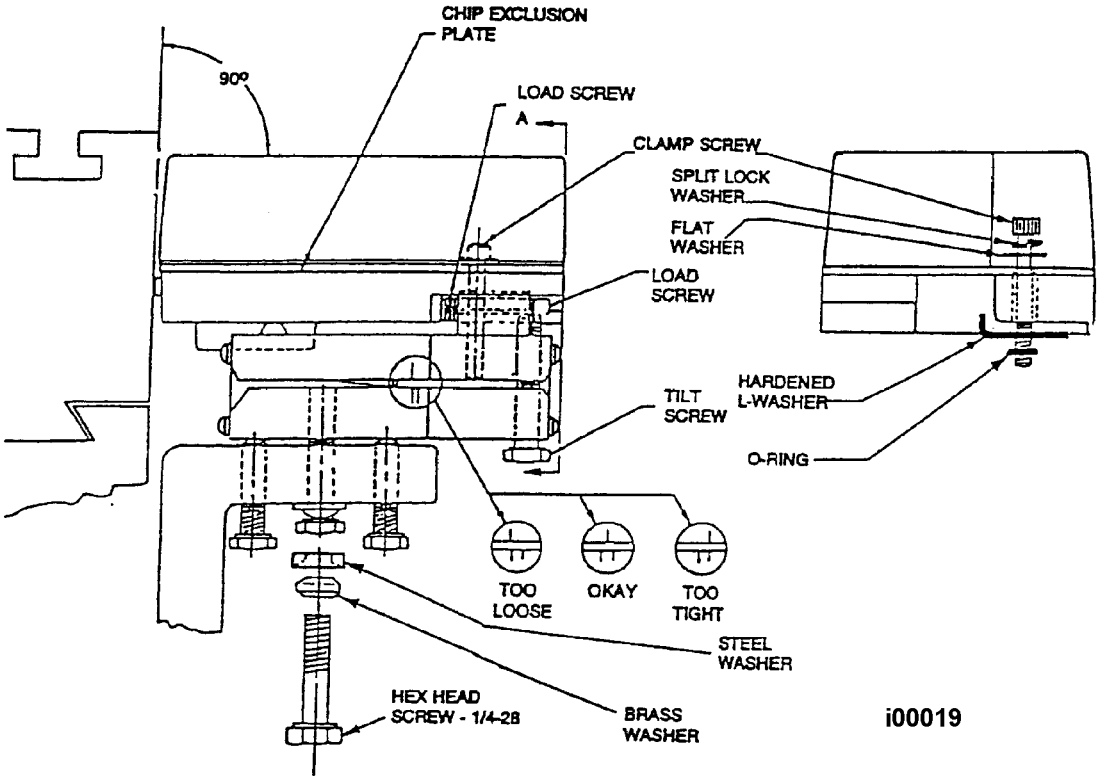

Figure 26
TRAK Sensor Mounting

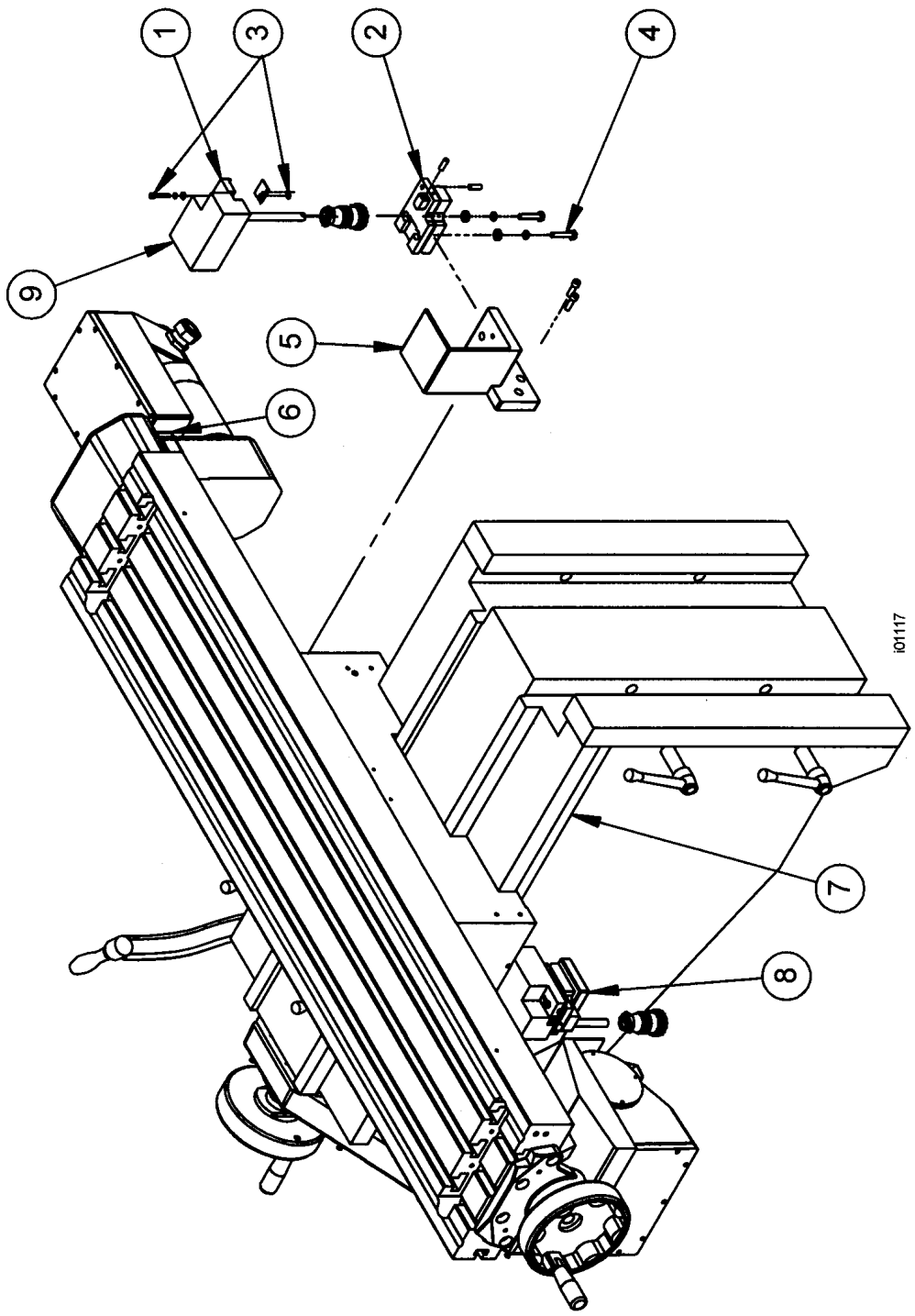

Figure 27
K Mill Sensor Assembly

K Mill Sensor Assembly Parts List

Item	P/N	DESCRIPTION
1	M250C	SENSOR - ALL TRAK PRODUCTS
2	M5	M-5 BASE
3	LDCEL-C	LOADCELL - M250C
4	M5 HDWR	HARDWARE - M5 BASE
5	16023-1	BRACKET-SENSOR X-AXIS (K2)
6	21511	EXTENSION
7	14600	BAR-RUN Y-AXIS
8	13384-4	BRACKET-SENSOR Y-AXIS (K2)
9	15346	CHIP SCRAPER-M250C
10	16023-2	BRACKET-SENSOR X-AXIS (K3 & K4)
11	13777-1	BRACKET UNIVERSAL BR17-RY MODIFIED (K3 & K4)

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5.1.7 Glass Scale Replacement

5.1.7.1 Remove the X, Y or Z Glass Scale

1. Unplug the glass scale connector from the cable breakout box.
2. Unbolt the reader head of the glass scale from its mounting surface.
3. Unbolt the glass scale enclosure from the table on X or the mounting spar on Y.
4. Install the head alignment bracket that came with the replacement scale to this scale to secure it for shipping back to SWI. Failure to do this may cause the glass scale to get damaged during shipment. The head alignment bracket secures the reader head so it cannot move and damage the glass in the scale.

Note: 1st align the reader head on the new scale before removing it to fasten the old scale.

CAUTION!
Once the head alignment bracket is installed, do not traverse the axis or the reader head will break.

5.1.7.2 Install the X or Y Replacement Scale

CAUTION!
If the scale is not long enough for the table, it will break when the machine is traversed past the scale travel.

1. Mount the scale to the back of the table or Y-axis mounting spar.
2. Align the sale so that it is within +/- 0.005" end to end.

Notes: For the Y-axis, the mounting spar should already be aligned. It must be parallel to the Y-axis travel within +/-.005" end to end both horizontally and vertically. The mounting spar can be aligned in and out by the use of the adjustment screw.

3. Line the reader head up with the mounting holes on the back of the saddle for the X-axis or the bracket on the Y-axis.
4. Install the reader head bolts but leave them loose.

5. Use the jackscrews on the reader head to compensate for some gap between the reader head and the reader head mounting bracket. Leave the alignment brackets attached to the reader head. This bracket assures the reader head is aligned to the glass scale.
6. Tighten each jackscrew until it touches the bracket and then back it off 0.001" or 0.002". Use a feeler gage to set the gap.
7. Tightening the reader head mounting screws. This ensures the reader head is aligned within a few thousandths.
8. Remove the shipping bracket that fixes the reader head to the scale for shipping.

CAUTION!
After the reader head is attached to the reader head-mounting bracket, do not move the machine axis until the shipping bracket is removed. This will break the reader head. This is not covered under warranty.

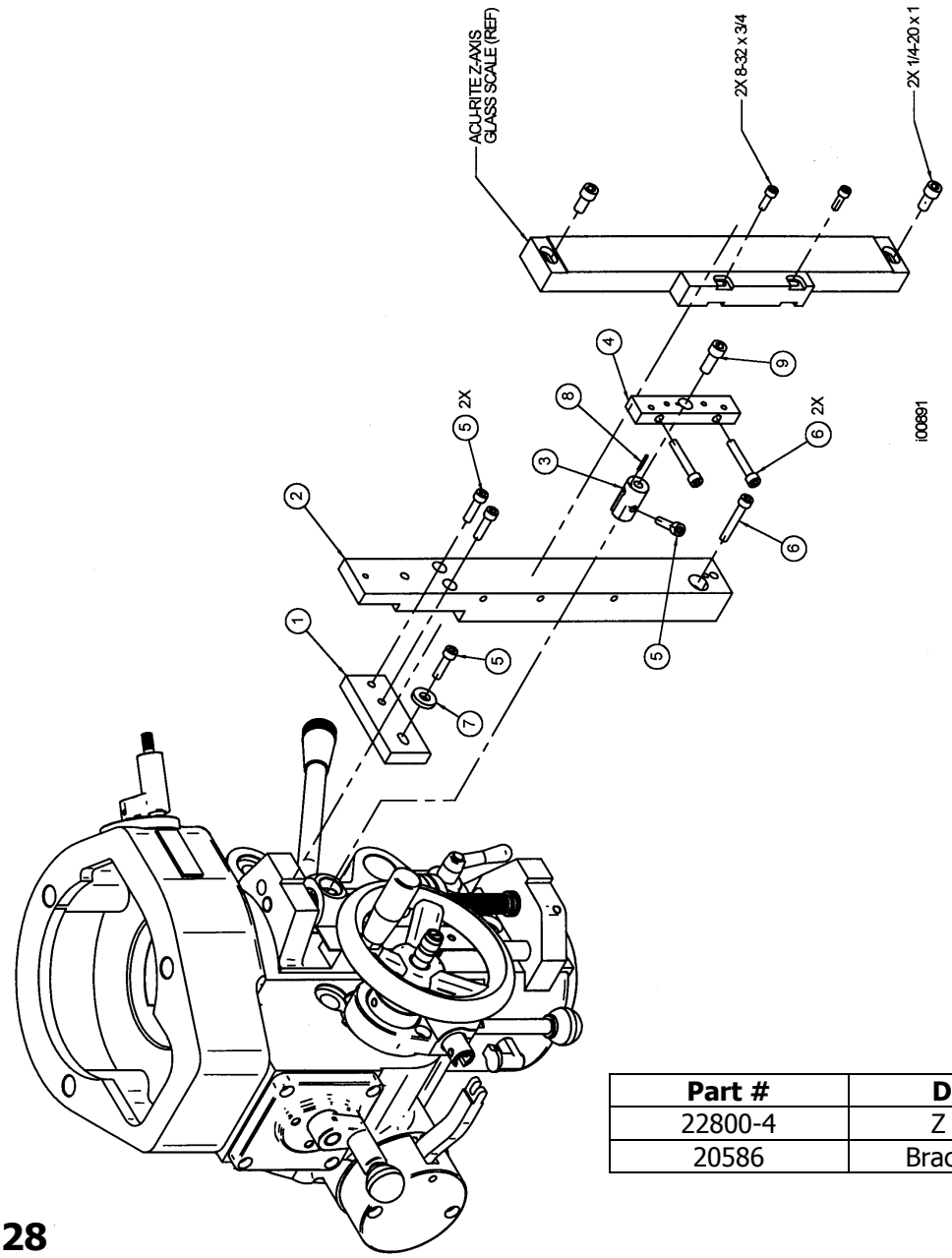
See Figure 29 for an illustration of how to align glass scales.

5.1.7.3 Install the Z-Axis Glass Scale

See Figure 28.

1. Check the tram of the head in the X direction. If it is within a few thousands then continue on. If not tram.
2. Assemble Z-axis glass scale mounting bracket and mount to head. Items 1, 2, 3 and 4. Tap items 3 and 4 together and tap item 3 into the quill stop knob. Leave the bolt loose. Use 2 screws (item 6) and mount item 4 to the side of item 2 using a spacer between both items to provide a gap of approximately 0.040" between Items 2 and 4. This is to make sure item 2 does not rub against item 4.
3. Align the glass scale bracket (Item 2) with an indicator and tighten the mounting screws. Leave the quill stop knob screws loose. Remove the spacer and bolts from Item 4.
4. Unscrew the shipping protection screw from the scale.
5. Mount the glass scale to the mounting bracket and align it with an indicator. It needs to be aligned within 0.008" with respect to the quill. Tighten the screws down.
6. Fasten the readerhead to the readerhead bracket.
7. Move the readerhead up and down the glass scale and make sure the gap is consistent between the readerhead and the glass scale. Tighten the screw to the quill stop knob.
8. Remove the red head securing plate.
9. If the gap is not consistent between the readerhead and the glass scale when moving the quill up and down then adjust the angle of the scale to make the gap consistent.

CAUTION!
The gap must be no larger than 0.060" between the readerhead and glass scale.



Part #	Description
22800-4	Z Glass Scale
20586	Bracket Assembly

Figure 28
K Mill Z-Axis Glass Scale Assembly

Item	P/N	Description	Qty
1	20550	ARM- Z-AXIS MOUNTING PLATE	1
2	20551	MOUNTING PLATE-Z-AXIS GLASS SCALE	1
3	20548	ADAPTER-Z-AXIS GLASS SCALE	1
4	20549	ADAPTER PLATE- Z-AXIS GLASS SCALE	1
5	10-32X3/4 25B	SCREW-SHCS-STL-BO	4
6	10-32X1 1/4 25B	SCREW-SHCS-STL-BO	3
7	15759	WASHER-1/4 HARD BLK OX 1/8 THK	1
8	1/16X1/2 81B	SPRING PIN	1
9	1/4-28X3/8 25B	SCREW-SHCS-STL-BO	1

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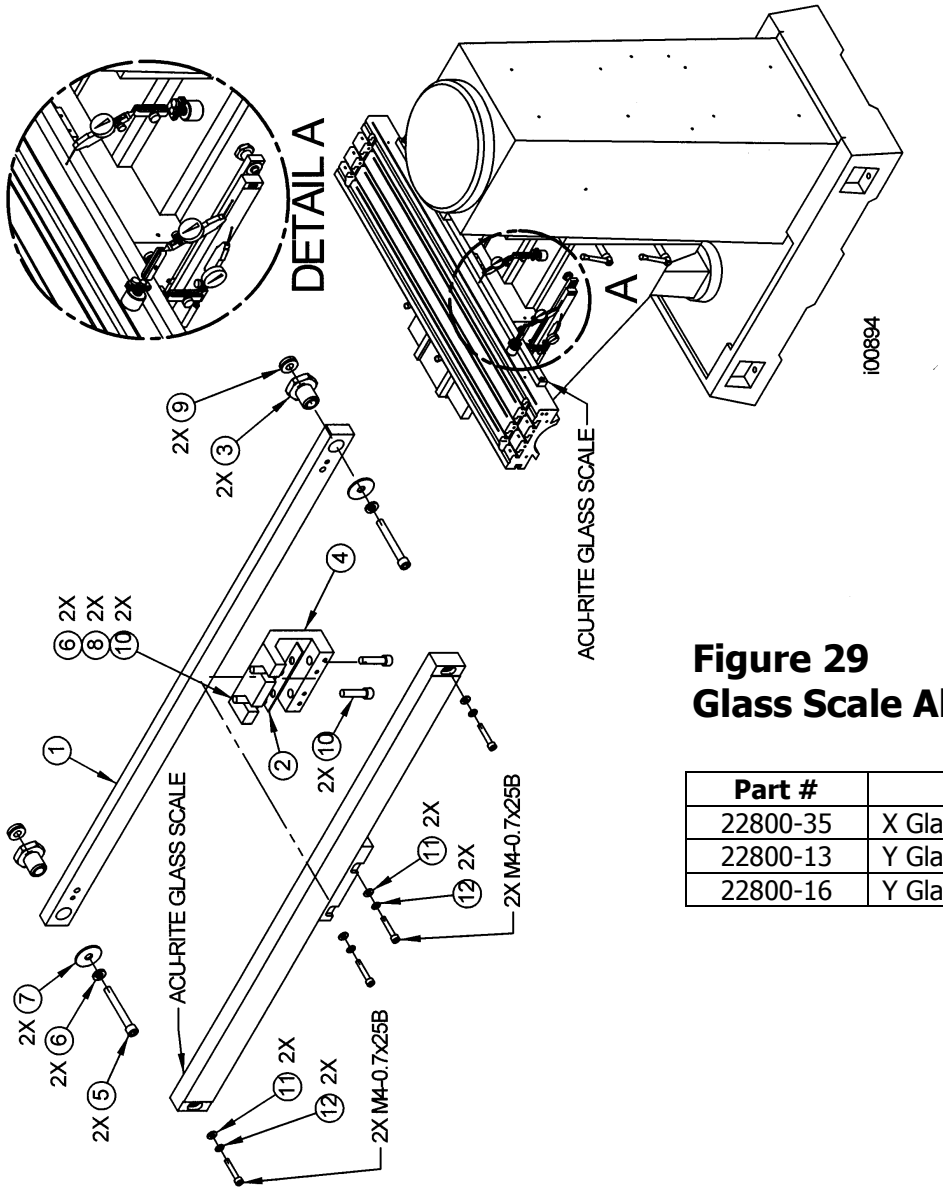

Figure 29
Glass Scale Alignment

Part #	Description
22800-35	X Glass Scale – K2/K3/K4
22800-13	Y Glass Scale – K2
22800-16	Y Glass Scale – K3 & K4

QTY	PART NUMBER	DESCRIPTION	NO.
4	91120A130	WASHER - EXTERNAL SERRATED LOCK	12
4	91166A230	WASHER - FLAT M4 70B	11
4	1/4-20x1.00 25B	SCREW-SHCS-STL-BO	10
2	1/4 72Z	WASHER-SPHERICAL (1 SET)	9
2	1/4 71Z	WASHER-USS FLAT-STL-BO	8
2	1/4x1.00-79Z	WASHER-FENDER 1/4" x1.00 O.D.	7
4	1/4 73Z	WASHER-SPLIT LOCK-STL-BO	6
2	1/4-20x2.00 25B	SCREW-SHCS-STL-BO	5
1	20904	MOUNTING BRACKET	4
2	20545	ADJUSTMENT SCREW	3
1	20546-1	SPACER-Y AXIS	2
1	20544	MOUNTING PLATE, Y AXIS	1

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5.1.8 Power Drawbar

A power drawbar is an optional item on a TRAK Knee mill machine. It is bolted to the top of the head by the use of 3 SHCS. Some machines may require a washer to space the unit up to the proper height to allow the drawbar to engage properly.

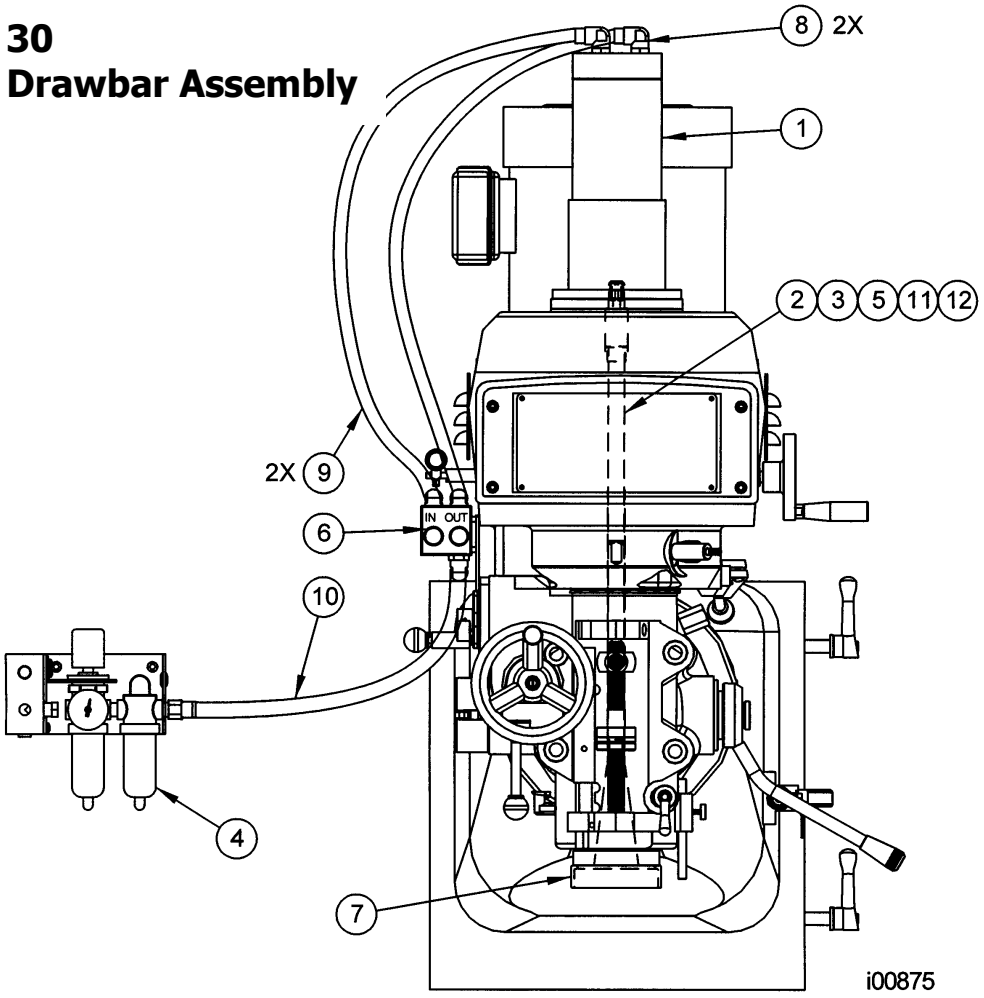
Air Regulator and Oiler - This unit requires between 80 and 100 psi to operate properly. Some units work fine at 80 psi while others may need 90 or 100 psi. It is also important to make sure the oiler for this unit is kept filled with oil. Fill the reservoir about 2/3 full using AIR TOOL OIL ONLY. Failure to do this will not allow oil to lubricate the internal components of the unit and it may wear out prematurely. It is also important to make sure the oiler is set properly. To set the oiler, first close the adjustment screw (CW) on top of the oiler completely making sure to not over tighten. Then open the screw (CCW) between ½ to ¾ of a turn. Any more than this will cause too much oil to get into the unit and oil may come out of the exhaust port of the unit.

Tool Alignment Device - This unit also comes with a tool alignment device, which attaches to the bottom of the spindle. This device allows the tool to easily be aligned with the dogs when loading a tool.

Note: Only used on K4 machines

CAUTION!
Some tools may not work with this device and the original spindle dogs will need to be used. The original spindle dogs are shipped with each machine in the toolbox. Some boring bar holders may not work with this device.

Figure 30
Power Drawbar Assembly



For item 4, see section 2.12 for a breakdown of parts.

Item	P/N	Title
1	22581-1	AIR GUN ASSY ONLY- TORQUE RITE
2	22605	DRAWBAR-R8 SPINDLE
3	20893	SPACER - DRAWBAR - R8 SPINDLE
4	22380-1 or -2	AIR REGULATOR ASSY (-2 with solenoid)
5	23888	SPACER - DRAWBAR - 40 TAPER SPINDLE
6	22581-2	SWITCH - CONTROL HEAD - TORQUE RITE
7	22581-4	NOSEPIECE FOR SPINDLE (40 taper heads only)
8		1/4" NPT AIR FITTING 90°
9		3/8 O.D. TUBING 132" LG.
10		3/8 O.D. TUBING 27" LG.
11	22641-NMTB	DRAWBAR - NMTB -40 TAPER
12	22641-CAT	DRAWBAR - CAT - 40 TAPER
13	TR220	SOCKET - AIR GUN REPLACEMENT (not shown on drawing)

i00875-1

5.1.9 Ball Screw Replacement, X-Axis (Table)

CAUTION!
Never screw a ball screw partially or totally out of its nut. They cannot be reassembled.

1. Y-axis motor mounting bracket and hardware must be removed to remove X yoke.
2. Position the table in the center of travel.
3. Remove the left side table tray by pulling it up, and remove the X motor (If machine has tray).
4. Remove the motor mounting bracket and bearing housing.
5. Remove the right side bearing housing.
6. Loosen the table gibs. Slide the table to the right and on to a lift that will support the table's weight. Slide the table until the yoke is exposed.

CAUTION!
The weight of the table must be supported by the lift to prevent damage or breakage to the dovetails.

7. Remove the 5/16 x 1" screws holding the ball nut to the yoke and loosen the 4 screws that mount the yoke to the saddle. Remove the oil line.
8. Tilt the yoke (it is pinned) to remove the ball screw.
9. Remove the elbow and setscrew from the old ball screw flange and fit them similarly in the new ball screw.
10. Pump oil to be certain it flows through the oil line and then attach the oil line to the elbow.
11. Reassemble all assemblies.

Important: The clamp nut must be reassembled as follows:

- Install rear bearing and seal into bearing housing and slide housing onto the ball screw. *(Note: Letters on bearings must face each other in the housing.).*
- Thread the split nut onto the ball screw and tighten the #10-32 clamp screw until you feel the split nut contact the ball screw threads. It should drag as you tighten the clamp nut.
- Torque the split nut to 50 ft. lb.
- Firmly tighten the #10-32 clamp screw to lock the clamp nut in place.

See the diagnostics section under Mechanical Drive Train for an explanation of how to align the ball screw.

See Figure 31 for an illustration of the X-axis drive train.

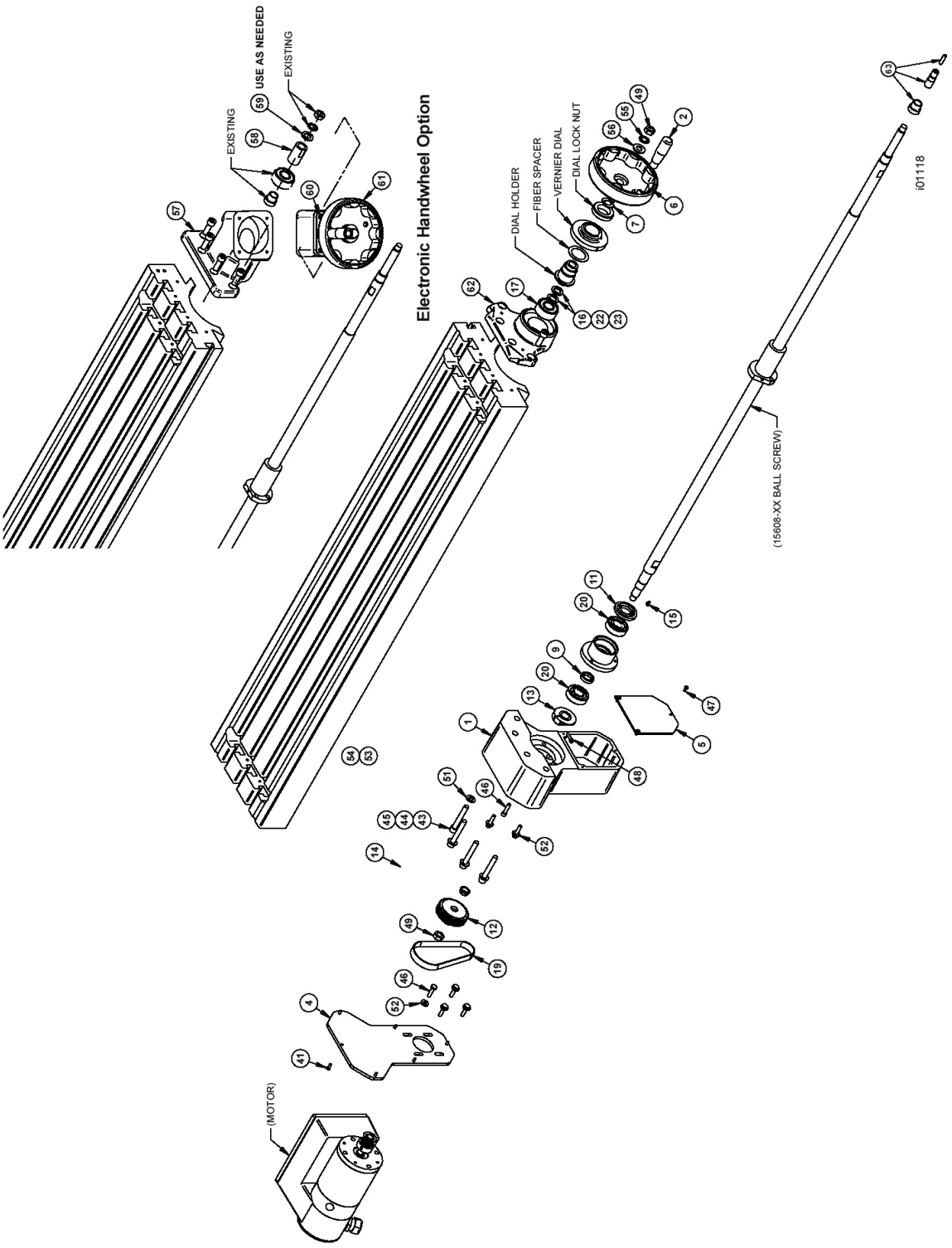


Figure 31
X-Axis Drive Assembly

X-Axis Drive Assembly Parts List

Item	P/N	Title	Qty
1	15621	DRIVE HOUSING	1
2	25729	HANDLE REPLACEMENT KIT	1
4	15624	FRONT COVER	1
5	15622	BACK COVER	1
6	15616	HANDWHEEL ASSY-MX	1
8	15612	HOUSING - BEARING	1
9	15885	RING-BEARING HOUSING	1
10	15638	STOP - X-AXIS (not shown on drawing)	1
11	15626	SEAL-BEARING HOUSING	1
12	16983-1	PULLEY-SOLID 44 TEETH W/O GUIDES	1
13	16452	NUT CLAMP-X ,Y, & Z AXIS	1
14	16350	FERRULE-SPROCKET	1
15	98481A090	KEY WOODRUFF #404-1/8 X 1/2	1
16	14772	SPACER - .100" THICK	5
17	22008	BEARING- 204KTT	1
19	400-5M-15	BELT - TIMING 5MM POWERGRIP	1
20	23930	BEARING-ANGULAR CONTACT- 7204 BECBP	SET
22	14772-2	SPACER - .020" THICK	2
23	14772-5	SPACER - .050" THICK	2
41	8-32X3/8 25B	SCREW-SHCS-STL-BO	6
42	5/16-18X1 25B	SCREW-SHCS-STL-BO	1
43	3/8-16X2 1/2 25B	SCREW-SHCS-STL-BO	4
44	M8-1.25X65 25B	SCREW-SHCS-STL-BO	4
45	M10-1.5X65 25B	SCREW-SHCS-STL-BO	4
46	1/4-20X1 24B	SCREW-HEX HD-STL-BO	7
47	8-32X3/8 20B	SCREW-RH-PHIL-STL-BO	3
48	10-32X3/4 25B	SCREW-SHCS-STL-BO	1
49	1/2-20 51Z	NUT-HEX JAM-STL-ZINC	2
51	M8 70P	WASHER-FLAT USS-STL-PLAIN	4
52	15759	WASHER-1/4 HARD BLK OX 1/8 THK	7
53	3/8 70P	WASHER-FLAT USS-STL-PLAIN	4
54	M10 70P	WASHER-FLAT USS-STL-PLAIN	4
55	1/2 73B	WASHER-SPLIT LOCK-STL-BO	1
56	1/2 70P	WASHER-FLAT USS-STL-PLAIN	1
62	22007	END CAP	1
63	15181	BALLSCREW EXTENSION	1
	15608-48	BALLSCREW - X AXIS	1

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X-Axis Electronic Handwheel Option Parts List

Item	P/N	Description	Qty
57	22718	SPACER-45 DEGREES X-AXIS	1
58	21992	BUSHING-BALLSCREW (X-AXIS)	1
59	14772	SPACER-.100” THICK	1
60	M6-1.0X75 25B	SCREW-SHCS-STL-BO	4
61	21946	ELECTRONIC HANDWHEEL	1

5.1.10 Ball Screw Replacement, Y-Axis (Saddle)

CAUTION!
Never screw a ball screw partially or totally out of its nut. They cannot be reassembled.

1. Position the saddle all the way forward.
2. Remove the hand wheel assembly and bracket.
3. Remove the sheet metal covers on the front of the machine bed and on the motor mounting bracket.
4. Remove the motor, then remove the motor mounting bracket.
5. Remove the rest of the parts on the ball screw journal. Note the orientation of the bearings for reassembly.
6. Remove the 5/16 x 1 inch screws that attach the ball nut to the yoke.
7. Remove the ball screw and oil line attached to the elbow fitting on the ball nut.
8. Remove the elbow and setscrew from the old ball screw flange and fit them similarly in the new ball screw.
9. Pump oil to be certain it flows through the oil line, and then attach the oil line to the elbow.
10. Reassemble all assemblies.

Important: The clamp nut must be reassembled as follows:

- Install rear bearing and seal into bearing housing and slide housing onto the ball screw. *(Note: Letters on bearings must face each other in the housing.)*
- Thread the split nut onto the ball screw and tighten the #10-32 clamp screw until you feel the split nut contact the ball screw threads. It should drag as you tighten the clamp nut.
- Torque the split nut to 50 ft. lb.
- Firmly tighten the #10-32 clamp screw to lock the clamp nut in place.

See the diagnostics section under Mechanical Drive Train for an explanation of how to align the ball screw.

See Figure 32 for an illustration of the Y-axis drive train.

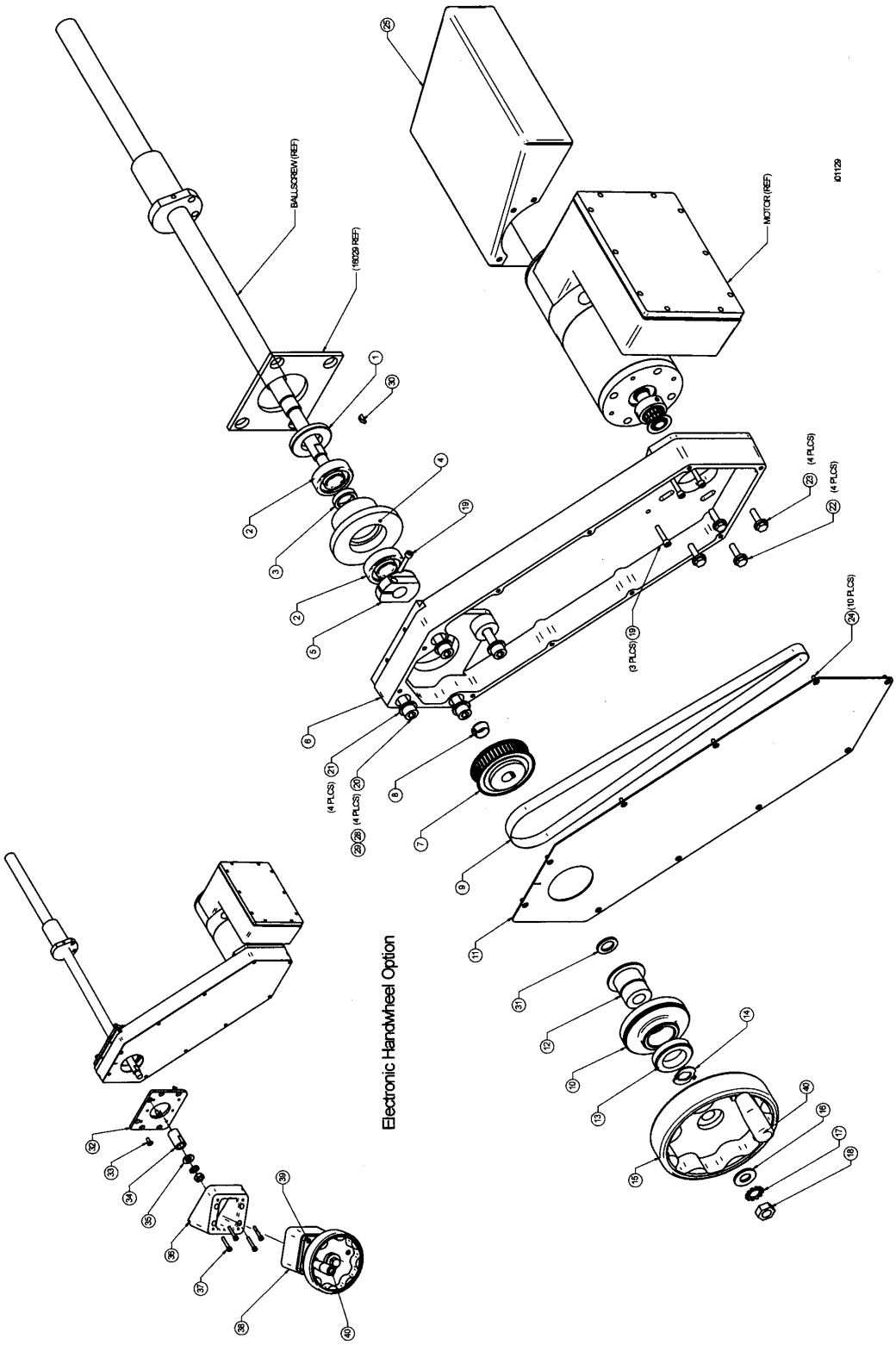


Figure 32 - Y-Axis Drive Assembly

Y-Axis Drive Assembly Parts List

i00912

Item	P/N	Description	Qty
1	15626	SEAL-BEARING HOUSING	1
2	23930	BEARING SET-ANGULAR CONTACT- 7204 BECBP	1
3	15885	RING-BEARING HOUSING	1
4	15980	BEARING HOUSING	1
5	16452	NUT CLAMP-X ,Y, & Z AXIS	1
6	20623	MOTOR BRACKET-KNEE MILLS-40 DEGR	1
7	16983-1	PULLEY-SOLID 44 TEETH W/O GUIDES	1
8	16350	FERRULE-SPROCKET	1
9	890-5M-15	BELT - TIMING 5MM POWERGRIP (Y AXIS)	1
10	16533	VERNIER DIAL-PT4	1
11	20621	COVER-SPORT 40 DEGREE	1
12	15627-2	DIAL HOLDER	1
13	15836	DIAL NUT	1
14	15614	TAB WASHER	1
15	15616	HANDWHEEL ASSY-MX	1
16	1/2 71Z	WASHER-FLAT SAE-STL-ZINC	1
17	1/2 75Z	WASHER-EXT TOOTH-STL-ZINC	1
18	1/2-20 51Z	NUT-HEX JAM-STL-ZINC	1
19	10-32X1 25B	SCREW-SHCS-STL-BO	4
20	M10-1.5X65 25B	SCREW-SHCS-STL-BO	4
21	23082	WASHER-.75X.394X.10-STL	4
22	1/4-20X1 24B	SCREW-HEX HD-STL-BO	4
23	15759	WASHER-1/4 HARD BLK OX 1/8 THK	4
24	6-32X3/8 10B	SCREW-PH-PHIL-STL-BO	10
25	23141	SHEET METAL-PT4-COOLANT MOTOR COVER ASSY	1
26	10-32X3/8 10B	SCREW-PH-PHIL-STL-BO	3
27	10 73B	WASHER-SPLIT LOCK-STL-BO	3
28	30922	HANDLE FOLD-A-WAY	1
30	98481A090	KEY WOODRUFF #404-1/8 X 1/2	1
31	14772-2	SPACER - .020" THICK	1
	20296R	MOTOR ASSY	1
	15609-12	Y BALLSCREW – K2	1
	15609-16	Y BALLSCREW – K3/K4	1

Y-Axis Electronic Handwheel Option Parts List

Item	P/N	Description	Qty
32	21984	BRACKET-WAY COVER FRONT Y-AXIS DRIVE	1
33	¼-20X5/8 26B	SCREW-FHCS-STL-BO	2
34	21992-1	BUSHING-BALL SCREW (Y-AXIS)	1
35	14772	SPACER-.100” THICK	1
36	21985	SPACER-30 DEGREES Y-AXIS	1
37	M6-1.0X25 25B	SCREW-SHCS-STL-BO	4
38	21946	ELECTRONIC HANDWHEEL	1
39	M6-1.0X75 25B	SCREW-SHCS-STL-BO	4

40	25729	HANDLE REPLACEMENT KIT	1

5.1.11 Air Solenoid Replacement – Auxiliary Function Machines Only

1. Unhook the air from the machine.
2. Unplug the power cable that connects to the right side of the air regulator bracket.
3. Remove the 2 screws that hold the connector to the bracket.
4. Undo the airline that runs from the oiler to the power drawbar if that option is installed on the machine.
5. Remove the 2 screws on the left side of the bracket that holds the air manifold to the U-shaped bracket.
6. With the assembly in hand, unthread the solenoid from the rear of the air regulator. The solenoid and cable will be replaced as a unit.

See Section 2.12, Figure 12, for an illustration of this assembly.

5.1.12 Spindle Motor Wiring

The K Mill spindle motors are wired for 220 or 440 volts. See Figure 33 for how to wire the motor. **NOTE: Machine with the Spindle Control Option can only be wired for 220V.**

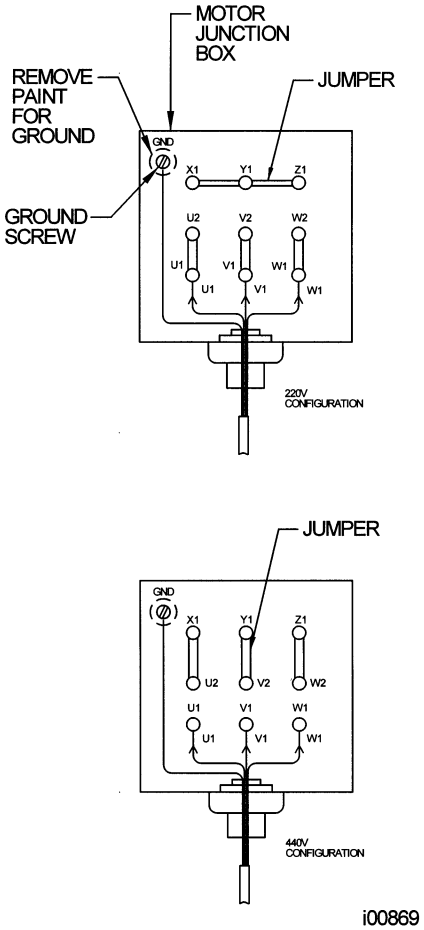


Figure 33
Spindle Motor Wiring

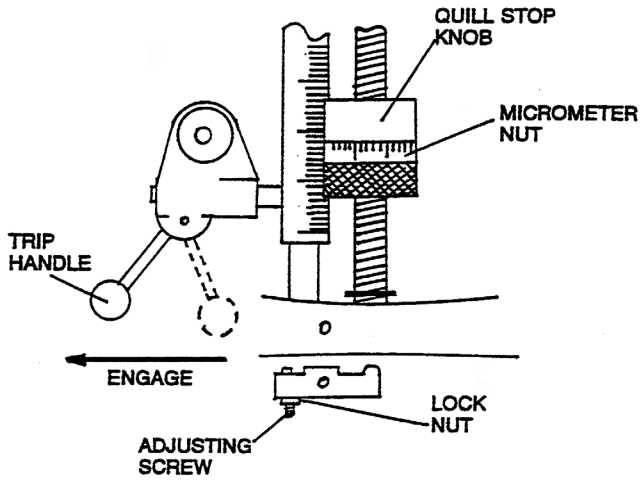
K2/K3/K4

5.1.13 Feed Trip Adjustment (not applicable to 3 axis controls)

If the feed trip is adjusted too light it will inadvertently trip when drilling. If too heavy, it will not trip accurately and stress the mechanism. The correct adjustment depends on the operation to be performed. To adjust:

1. Release the lock nut.
2. Engage the trip handle--move it left.
3. Adjust the micrometer nut against the quill stop knob.
4. Slowly turn the adjusting screw until the handle trips.
5. Tighten the lock nut.
6. Check the reaction. If too sensitive, lower the adjusting screw slightly. If too heavy, raise it.

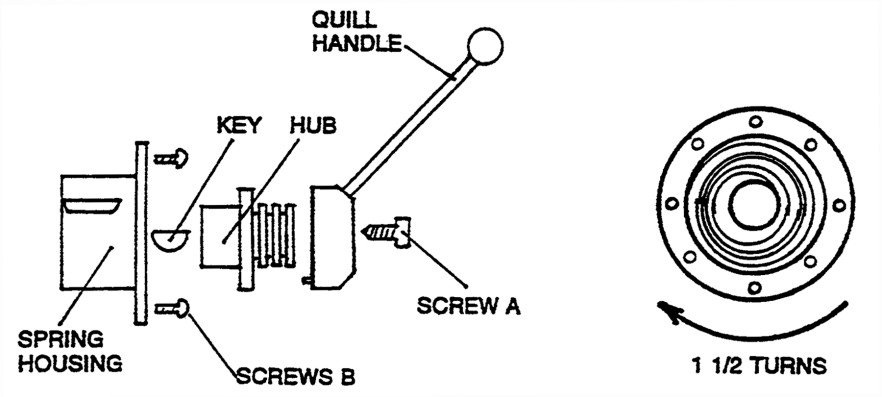
Figure 34



5.1.14 Quill Clock Spring Replacement and Adjustment

The quill Clock Spring counterbalances the weight of the quill and tool.

Figure 35



1. Move the quill to its top position and lock it in place.
2. Remove the quill handle, hub (by removing Screw A) and key.
3. Remove Screws B and allow the spring housing to unwind.
4. Remove the spring. It is held by a pin on the shaft and slot in the housing.
5. Replace the spring. Rotate the housing clockwise until the spring catches the shaft pin.
6. Rotate (wind up) the housing 1 1/2 turns, replace Screws B, key hub, Screw A, and handle.

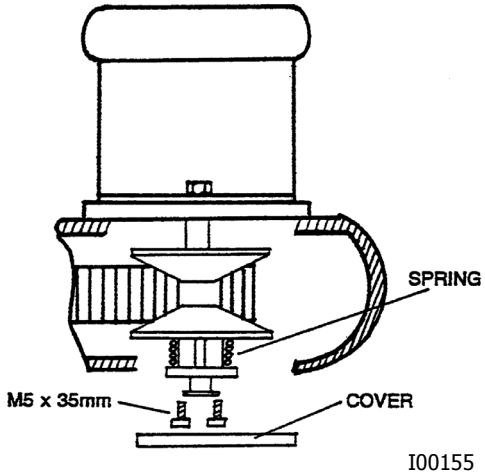
5.1.15 Spindle Motor Removal and Replacement

1. While the spindle is running, change the RPM to its lowest value.
2. Disconnect the power to the motor. It is recommended that the power disconnect be made from the shop feeder box.
3. Disconnect the electrical connection in the conduit box attached to the motor.
4. Crank the speed changer to the highest RPM value.
5. Remove the two screws that fasten the motor to the top of the housing.

CAUTION!
The motor is heavy--about 60 pounds. Be certain you have the proper equipment or assistance.

6. Tilt the motor toward ram and remove the belt from the motor pulley. Remove motor.
7. If the motor is to be replaced, remove the M8 socket head cap screw at the end of the motor shaft. Slide the pulley assembly off the motor shaft and onto the new motor.

Figure 36



5.1.15.1 Spindle Motor Removal and Replacement for machine with the Spindle Control option

1. Disconnect the power to the motor. It is recommended that the power disconnect be made from the shop feeder box.
2. Disconnect the electrical connection in the conduit box attached to the motor.
3. Remove the three bolts that hold the motor pulley cover in place to gain access to the belt.
4. Remove the four bolts that mount the motor to the top head housing and slide motor forward and remove belt.

CAUTION!

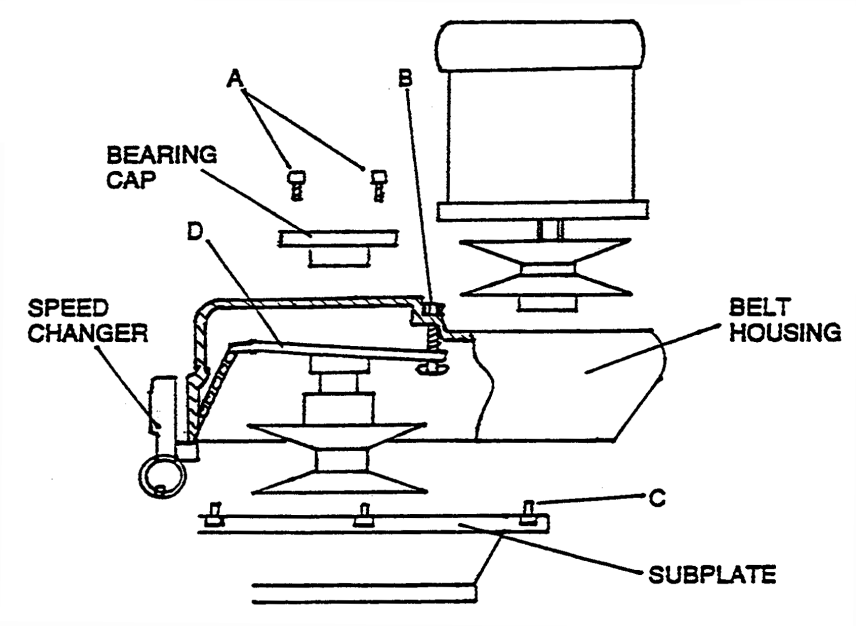
The motor is heavy--about 80 pounds. Be certain you have the proper equipment or assistance.

5. Tilt the motor towards the back and remove the belt from the motor pulley. Remove the motor.

5.1.16 Drive Belt Replacement

1. Remove the motor.
2. Remove the draw bar and its bushing.
3. Remove the three Screws A and use M6 x 35mm screws in the adjacent tapped holes to remove the Bearing Cap.
4. Remove the nut from the fine speed adjustment Screw B and turn the screw all the way down through the casting. Catch it from the motor hole.
5. Remove six Screws C holding the belt housing to the subplate.
6. Remove the four screws holding the speed changer.
7. Remove the belt housing.
8. Replace the belt by sliding it over the speed changer.
9. In reassembly be certain the fine speed adjustment Screw B goes into the slot of the Speed Change Plate D in the area in which the screw is not threaded.

Figure 37



i00156

5.1.16.1 Drive Belt Replacement for machine with the Spindle Control option

1. Remove the draw bar and its bushing (remove power drawbar if present).
2. Remove the three Screws A and use M6 x 35mm screws in the adjacent tapped holes to remove the Bearing Cap (see Figure 36).
3. Follow instructions for spindle motor removal and remove motor so top head housing can be removed with ease.
4. Remove the six screws "C" that hold the belt housing to the subplate.
5. Disconnect the spindle control harness at the head control box.
6. Lift off the belt housing, then remove belt.

5.1.17 Timing Belt Replacement

1. Remove the motor and drive belt.
2. Slide the top or adjustable vari-disc pulley assembly off the shaft.
3. Remove the three M8 screws holding the belt housing base to the gear housing.
4. Lower the quill about 4 inches.
5. Remove the belt housing base and lower or stationary vari-disc pulley assembly.
6. Replace the timing belt.

5.1.18 Brake Shoe Replacement

1. Remove the motor, drive belt and complete Steps 1-5 of the timing belt replacement procedure.
2. Remove the two M6 cap screws from the bottom of the belt housing base.
3. Separate the belt housing base from the lower or stationary vari-disc pulley. This is a slight press fit.
4. Remove the 2 springs.
5. Replace the brake shoes.

5.1.19 Spindle Replacement

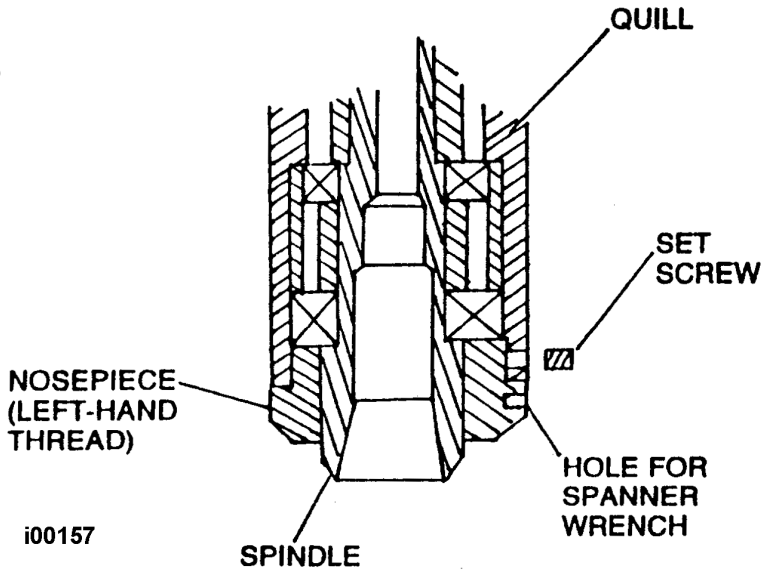
1. Remove the draw bar and its bushing.
2. Lower the quill about 1 inch and lock.
3. Remove the setscrew from the back of the spindle.
4. Loosen (unscrew) the large black ring (nosepiece) with a spanner wrench.

Note: The nosepiece has a left hand thread-- rotate counterclockwise to loosen.

5. Using a soft bar about 12 inches long, alternately tap on the top of the spindle and loosen a few threads on the nosepiece until fully unscrewed (the nosepiece will remain attached to the spindle).

6. Continue to tap the spindle out of the quill. The spindle bearings will come out with the spindle.

Figure 38



5.2 Maintenance

5.2.1 Gib Adjustments

The objective of adjusting the gibs is to eliminate as much play in the table, saddle and ram sliding surfaces as possible without having the tightness of the gib interfere with their free movement and cause a decrease in the accuracy and/or performance of the machine due to excessive friction.

5.2.1.1 Table Gib Adjustment, X-Axis

See Figure 39.

1. Clean all chips, dirt and excess oil from the table and saddle.
2. Center the saddle on the bed ways.
3. Move the table fully to the left side of the saddle.

   Note: For machines that have excessive wear in the center of the table way, it will be necessary to center the table on the saddle. The resulting adjustment of the gib will be compromised to account for the varying clearance from the center to the ends of the table.

4. Attach a .0001 dial indicator with a magnetic base to the left front of the saddle. Place the indicator stylus on the front surface of the table as close to the indicator base as possible.

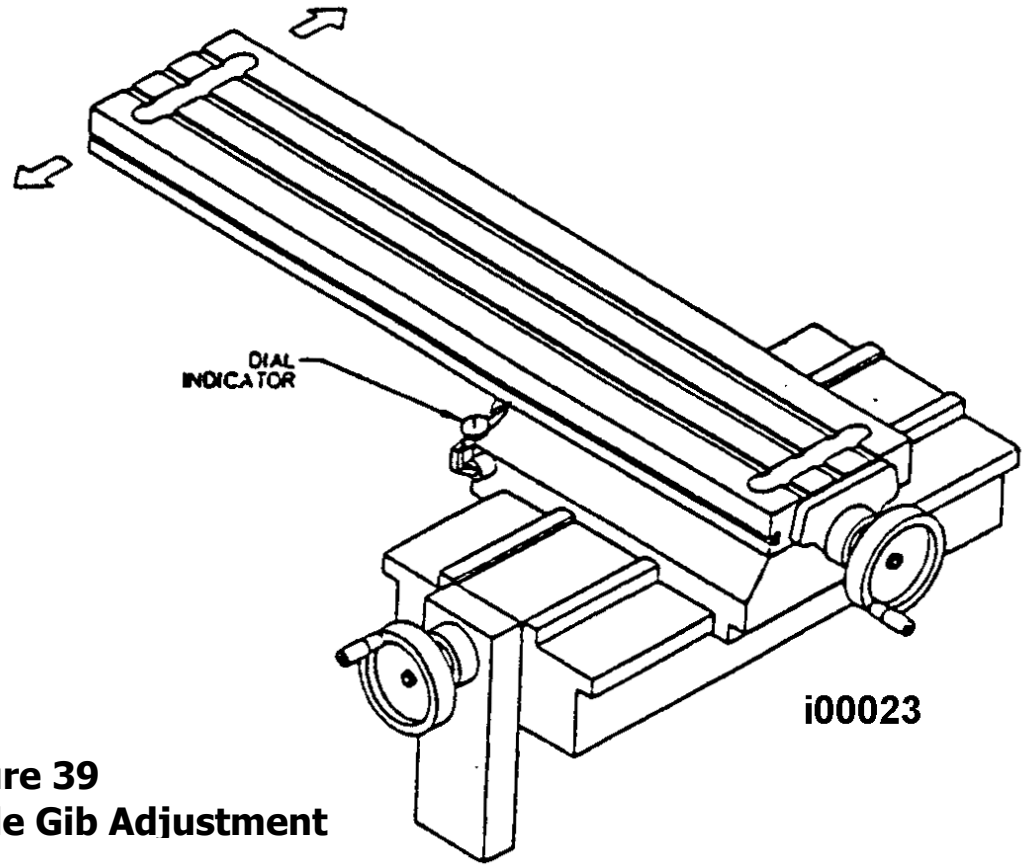


Figure 39
Table Gib Adjustment

5. Move the left end of the table back and forth and note the amount of movement on the dial indicator. Adjust the X-axis gib until the registered movement is .0010-.0015.

   - To adjust the gib for excessive clearance: Loosen the gib lock screw on the right end of the saddle. Estimate the amount of gib lock screw adjustment required, and tighten the gib lock screw on the left end of the saddle. Tighten the gib lock screw on the right end of the saddle to lock the give in place, and recheck. Repeat as necessary.

   - To adjust the gib for too small of a clearance: Loosen the gib lock screw on the left end of the saddle. Estimate the amount of gib lock screw adjustment required, and tighten the gib lock screw on the right end of the saddle. Tighten the gib lock screw on the left end of the saddle to lock the gib in place, and recheck. Repeat as necessary.

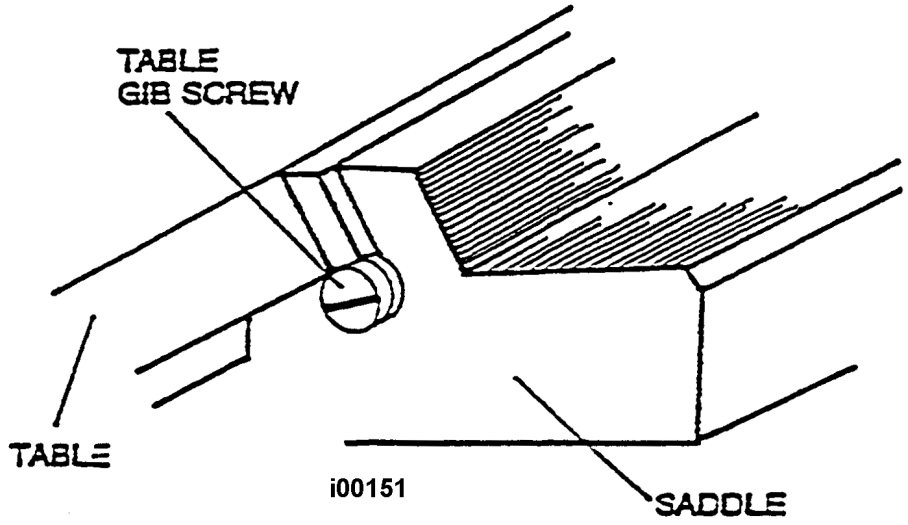


Figure 40
Table Gib Screw

5.2.1.2 Saddle Side Gib Adjustment, Y-Axis

See Figure 41.

1. Clean all chips, dirt and excess oil from the table and saddle.
2. Center the saddle on the bed ways.
3. Move the table fully to the left side of the saddle.
4. Remove the chip wiper guard and chip wiper from the front and rear of the left side box way.

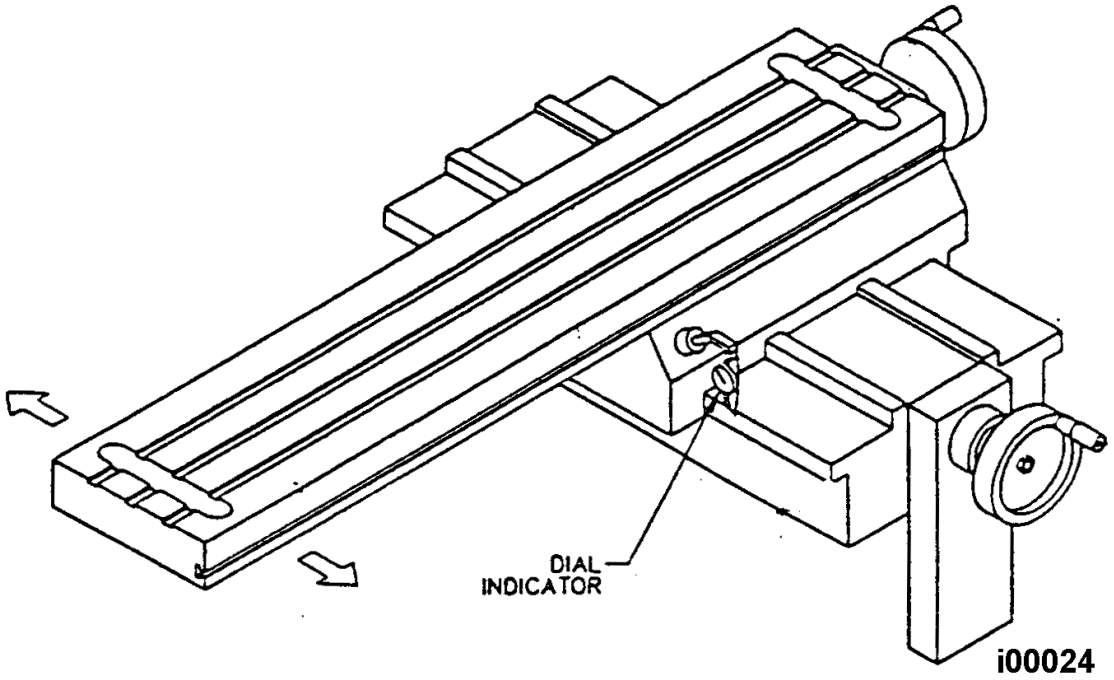


Figure 41
Saddle Side Gib Adjustment

5. Attach a .0001 dial indicator with a magnetic base to the left front of the saddle. Place the indicator stylus on the edge of the large box way.
6. Move the left end of the table back and forth and note the amount of movement on the dial indicator. Adjust the Y-axis side gib until the registered movement is .0010-.0015.
   - **To adjust the gib for excessive clearance**:
     Loosen the gib lock screw on the back of the saddle. Estimate the amount of gib lock screw adjustment required, and tighten the gib lock screw on the front of the saddle. Tighten the gib lock screw on the back end of the saddle to lock the gib in place, and recheck. Repeat as necessary
   - **To adjust the gib for too small of a clearance**:
     Loosen the gib lock screw on the front of the saddle. Estimate the amount of gib lock screw adjustment required, and tighten the gib lock screw on the back of the saddle. Tighten the gib lock screw on the front of the saddle to lock the gib in place, and recheck. Repeat as necessary.
7. Replace the front and rear chip wiper, and chip wiper guard.

5.2.1.3 Saddle Bottom Gib Adjustment, Y-Axis (K3 and K4 Only)

See Figure 42.

1. Clean all chips, dirt and excess oil from the table and saddle.
2. Center the saddle on the bed ways.
3. Move the table fully to the left side of the saddle.

4. Attach a .0001 dial indicator with a magnetic base to the left front of the saddle. Place the indicator stylus on the top surface of the box way.
5. Lift the end of the table up and note the amount of movement on the dial indicator. Adjust the Y-axis left bottom gib until the registered movement is .0010-.0015.
6. Move the table fully to the right.
7. Reposition the indicator to the right front of the saddle.
8. Lift the right end of the table up and note the amount of movement on the dial indicator. Adjust the Y-axis right bottom gib until the registered movement is .0010-.0015.

- **To adjust the gib for excessive clearance**:
  Loosen the gib lock screw on the back of the saddle. Estimate the amount of gib lock screw adjustment required, and tighten the gib lock screw on the front of the saddle. Tighten the gib lock screw on the back end of the saddle to lock the gib in place, and recheck. Repeat as necessary.

- **To adjust the gib for too small of a clearance**:
  Loosen the gib lock screw on the front of the saddle. Estimate the amount of gib lock screw adjustment required and tighten the gib lock screw on the back of the saddle. Tighten the gib lock screw on the front of the saddle to lock the gib in place, and recheck. Repeat as necessary.

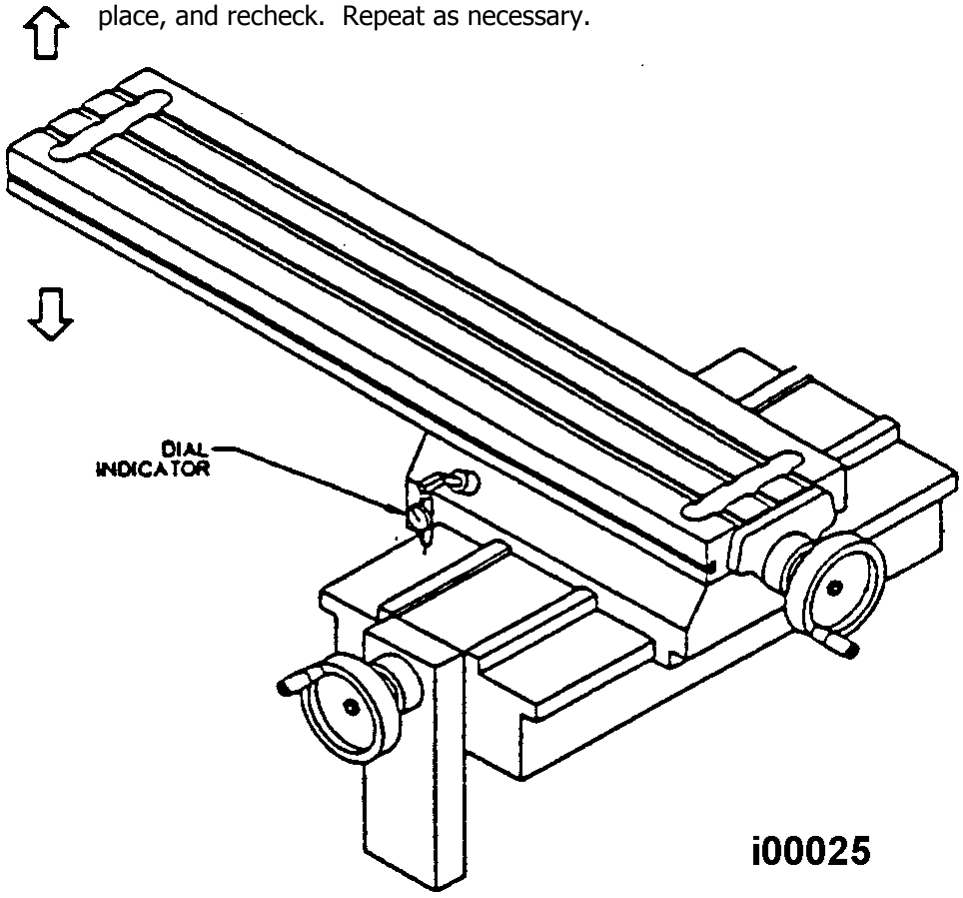


Figure 42
Saddle Bottom Gib Adjustment (K3 & K4 Only)

5.2.2 Calibration & Backlash Constants

Calibration and backlash constants were set as part of the installation and set-up of your system. They should be re-set when indicated in the Troubleshooting section or after the replacement of the Computer module, or any parts of the drive train.

5.2.2.1 X, Y, Z and Quill Calibration

Calibration is used teach the machine a known distance. We typically calibrate our machines over a 150 mm distance. There is no limit to how far you can calibrate the machine.

1. If you have installed TRAK Sensors, move each axis through its travel 4-6 times in order to allow the gage wheel to establish its track.
2. Set-up a gauge block or standard and indicate it parallel to the axis you are calibrating.

   Note: Put the display in Inch or mm to match your gage block. Recommended gage blocks are:

   - X and Y -- 150mm or 6"
   - Z -- 75 mm or 3"
3. Set a 0.0001" indicator in the spindle and move it up to one side of the gage block or standard.
4. Go to setup mode, go to section "B" and press CODE 123.
5. Select the axis you want to calibrate X, Y or Z. For the quill press the F1 key labeled QUILL. The Z key is used to calibrate 3 axis machines only.
6. Follow the instructions on the screen to complete calibration.

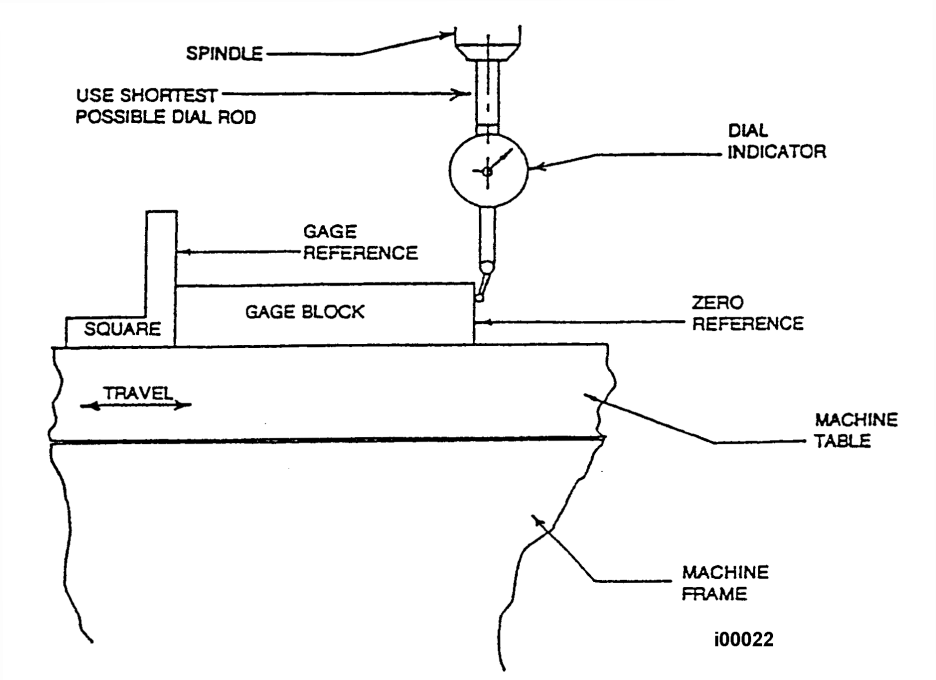


Figure 43
Calibration Set-Up

5.2.2.2 Backlash Compensation

Code 11: Set X or Y backlash constant

Note: this procedure is on systems with TRAK Sensors or Glass Scales only.

Go to setup mode, go to section "B" and press CODE 11. Refer to service code section for further explanation.

Code 127: Set X or Y Backlash Constant

Note: this procedure is only for systems without TRAK Sensors or Glass Scales.

Every mechanical system has at least a little backlash or lost motion. It is produced by the small amount of play between the gibs and ways, and mostly by the accumulative bending or elasticity of all the parts of the drive train under load. The backlash constant is factory set, but may need to be adjusted periodically.

1. Set a .0001-inch dial indicator in the spindle, and touch off on a block or the vise along the direction (X or Y) you wish to check, or set the backlash constant.
2. Turn on the ProtoTRAK and at the Main Menu, follow the procedure below precisely:

Conversation Says	You Do
a. ---	a. Press MODE
b. Select Mode	b. Press SET UP
c. Select	c. Press SERV CODES
d. Select	d. Press "B"
e. Select Code 127	e. Press X or Y
f. Backlash Value = _ _ _ _	f. What is shown is the current value. Follow the instruction on the screen and press the appropriate soft keys. Wait a few seconds between each INCR VALUE or DECR VALUE press.
g. The following is an example of what you might see when running this code.	For example, if the up and down "Oscillation Value" shown in the conversation line is .00278 inch, and the dial indicator is moving back and forth .0012, then the true backlash value is .00278 -.0012 = .00158 inch. Input this by pressing MODE, SET UP, SERV CODE, 128, SET and then .00158, SET, RETURN.

3. The X backlash identified and stored in Step 2 should be less than 0.003" on a new machine. If it is appreciably larger, inspect the drive train for loose bolts, brackets, bearings, etc.

   The backlash can also be found manually with a 0.0001" indicator with the following method.

   - Load the indicator to zero from one direction and zero out the DRO.
   - Move the indicator to 0.002" and then back to zero. Do not over shoot 0, otherwise start over.

- Whatever number appears on the screen is the backlash value.
- Enter this value into service code 128.
- After entering this number redo the process. The DRO and indicator should now both read 0.

CODE 128: Input Backlash Constant

Code 128 allows you to enter the backlash values for each axis. It displays the value after it enters. This code is only used on machines with single feedback.

5.2.3 Head Rotational and Tramming

The TRAK knee head is free to rotate up to 90 degrees to the right or left. The K2 and K3 can also rotate 45° front to back. The K4 machine cannot rotate front to back.

5.2.3.1 To Rotate the Head Side to Side:

1. Loosen the four locknuts.
2. Rotate the head with the adjusting worm shaft. When rotating to greater than a 45^{o} angle, support head by hand.
3. Tighten the locknuts. Snug each locknut, then lightly tighten each locknut, then fully tighten each locknut in a crisscross pattern.
4. Use the method shown in the figure below and a parallel bar to square the head to the table.

5.2.3.2 Tramming the Head

The purpose of tramming the head is make sure the head is perpendicular to the top of the table from both side to side and back to front.

Side to side tolerance – 0.001”

Side-to-Side Alignment

1. Make sure the machine is level.
2. Make sure the table has been clean and the Z gibs are adjusted properly. Mount a dial indicator in a tool holder and mount in the quill.
3. Adjust the Y-axis so that the spindle is in the center of the table.
4. Adjust the Knee so that the dial indicator will reach the table.
5. Move the dial indicator to 6 o’clock position and adjust the face so the needle is zero.
6. Do a series of sweeps from 9 o’clock to 3 o’clock and check for the repeatability of the setup. The head should be trammed within ± 0.002”
7. If the head is out of tram from side to side then loosen the 4 head bolts and rotate the head with the worm shaft.
8. Once the head has been trammed, tighten the 4 heads bolts. Be careful not to move the head while tightening. Tighten the bolts in a criss-cross pattern. Torque = 30-35 lb.ft.

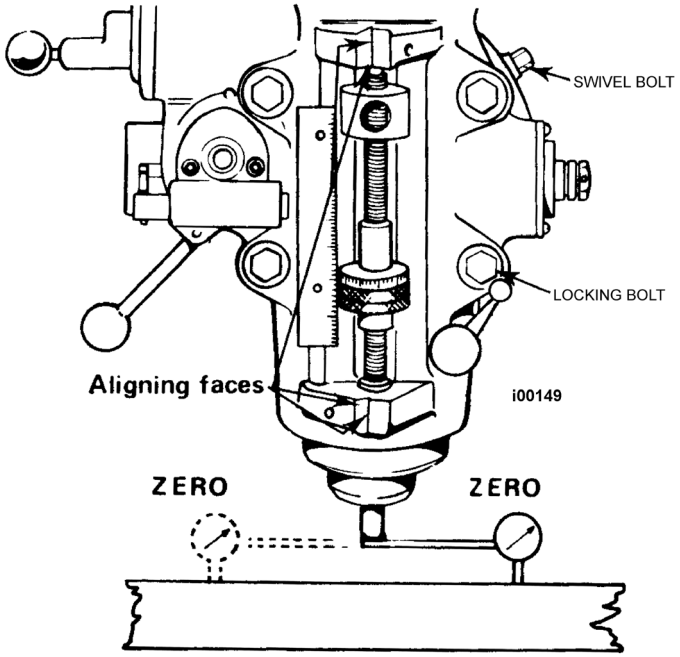


Figure 44
Tramming of Head

Back to Front Adjustment

Note: The head of the K4 milling machine is adjusted at the factory.

With the dial indicator sweep the table from 6 o'clock to 12 o'clock. The head should be trammed within ± 0.0006" over 9 or 10" tram diameter. 9 or 10" is based on the table width.

5.2.3.3 Back to Front Adjustment – K2/K3 only

1. Make sure the table has been clean and the gibs are adjusted properly.
2. Mount a dial indicator in a tool holder and mount in the quill.
3. Adjust the Y-axis so that the spindle is in the center of the table.
4. Adjust the knee so that the dial indicator will reach the table and lock the 2 clamps on the knee.
5. Move the dial indicator to 6 o'clock position and adjust the face so the needle is zero.
6. Do a series of sweeps from 6 o'clock to 12 o'clock and check for the repeatability of the setup. The head should be trammed as close as possibility to ± 0.0005"
7. Loosen the three bolts and adjust the tram with the bolt mounted on the top of the ram.

Once the head has been trammed tighten the three bolts. Be careful not to move the head while tightening. Tighten the bolts a little at a time. (Note: the head must droop down rather than up because tool pressure will take care of the extra 0.0005".)

5.2.4 Limit Switch Option

See figures 64 and 65 in section 7.

The limit switch option design was changed from when we first released the SX control. Early limit switch kits came with a single input limit switch as shown in the figure.

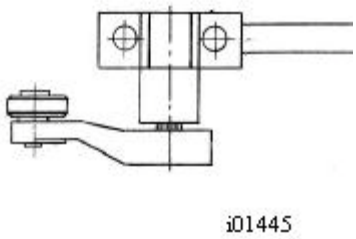


Figure 45 – 1 Input Limit Switch

#	Part Number	Description
1	16117	Limit Switch Assembly with cable

The latest design consists of a limit switch with 2 inputs as shown in the figure. This means 1 input for each direction. On machines with electronic handwheels, when you hit a limit the EHW will only allow you to move the machine in the direction away from the limit switch. This will prevent the user from damaging the machine by hitting a hard stop.

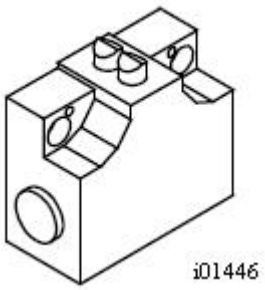


Figure 45-1– 2 Input Limit Switch
Part number – 22408

#	Part Number	Description
1	22408	Limit Switch (no cable)
2	22551-1	Limit Switch Assembly with cable – right
3	22551-2	Limit Switch Assembly with cable – left

5.2.4.1 X-Axis Limit Switch-Stop Installation and Adjustment

The limit switch-stops/cams for the X-axis are mounted to the front side of the table and can be adjusted along the length of the T slot. Each limit switch-stop must be set to a specific distance from the end of the table in order to maximize travel and simultaneously prevent serious damage to the machine in the event of a crash. All limit switches are set at the factory for maximum travel.

Procedure for Setting X Limit Switch

1. Loosen the stops or cams on each side of the table.
2. Slide each stop or cam within the T-slot to the end of the table.
3. Slowly move the table to one side by hand until the end of the travel is reached.
4. In DRO mode set X = 0 ABS.

CAUTION!
The limit switch must be triggered a minimum of ½" before the machine reaches its travel limits in both directions. This allows sufficient room for the servomotors to stop when the limit switch is hit at 150 ipm.

5. Using the DRO display, back the table off 1/2".
6. Lock the limit switch bracket in place.
7. Jog the table at 100ipm to each side and verify that the limit switch is working properly. Also, make sure that the table does not exceed its travel and crash.

5.2.4.2 Y Axis Limit Switch-Stops

The limit switch-stops for the Y-axis are mounted on the side of the knee. The limit switch is triggered by hitting the cam stop on the saddle. The cam is placed to ensure maximum travel. The 2 input limit switch design allows for slight adjustment of each cam.

6.0 Retrofit Installation

This section of the manual is intended to provide step-by-step instructions for installing a ProtoTRAK SMX 2 or 3-axis control on a vertical knee milling machine. Within Sections 6, 7 and 8 it may refer to other sections of the manual for certain procedures or figures.

6.1 Installation Tools and Hardware

The following section lists the required tools and hardware for installing a ProtoTRAK SM control. It also lists the pre-installation requirements needed to complete the retrofit at the customers shop.

6.2 Required Tools/Hardware

The following tools are necessary for a typical installation:

- Allen wrenches, set, inch and metric
- Drill motor
- Drills, set
- Taps, set, and tap handle
- Machinist square
- Bubble level
- Crescent wrench, 10”
- Torque wrench, up to 60 ft/lbs.
- Crowfoot wrench, 1 1/4” open end to fit torque wrench
- Socket set with 3” and 6” extension and ratchet wrench
- Dial calipers
- Flat blade screwdriver set
- Phillips screwdriver set
- Standard or gauge blocks, 6”/150mm
- Gauge block, 75mm or 3”
- .0001” dial indicator and magnetic base
- Center punch
- Hammer, small
- Combination wrenches, set, 3/8” to 15/16”
- Counterbores or step drills set
- Combination wrench, 10mm
- Transfer punch set
- Transfer screw set
- Feeler gage (Z glass scales)
- Pliers set
- File set
- Xacto knife with flat blade
- 3/4” 2 flute end mill
- Safety glasses

6.3 Suggested Fastener Stock

It is suggested that the ProtoTRAK installer have on hand the following fasteners in the event that they are inadvertently left out of the kit or lost during installation:

Qty	Fastener
8	5/16-18”x1 1/2” shcs, ballnut to yoke (BP)
6	10-32x3/8 shss, ballnut oil plug
7	1/4-20x1” hhcs, bearing housing to drive housing bracket
4	3/8-16x2 1/2 shcs, drive bracket to table
4	oil line elbow, 15187
4	brass fitting, 15696
2	T-fitting, P2 TUB-2
10	Washers, 15759
1	3/8-24 screw, 16355-1
6	Spacer, 14772
6	8-32x3/8: shcs, mounting bracket plate
3	8-32x7/8 round head Phillips
2	1/2-20 nut
4	Washer, flat 3/8, 98017A200
2	Lockwasher, 91114A033
12	6-32x3/8 flat head Phillips
3	5/16-18x2 shss
2	5/16-18x1 shcs
1	M10-1 screw, 16364-1
1	M10-1.5 screw, 16364-2
1	M10-1.5 screw, 16355-2
2	10-32x1
1	5/8-11 nut
3	M6 x 20 shcs – used to mount cable breakout box

SWI offers a complete set of spare fasteners and spare parts for ProtoTRAK installers at a special price. Contact the SWI Customer Service Group for details.

6.4 Pre-Installation Requirements

- Power requirements: 115V, 60Hz, 1100VA, 12-amp power line dedicated to the ProtoTRAK.
- Adequate working area around the machine to slide the table completely off the saddle.
- Availability of a lift table or cart capable of supporting the table once it is removed from the machine.

7.0 Installation Procedures

7.1 X and Y Ball Screw Installation

7.1.1 Removing the Table and Leadscrews

Note: Before removing any of the assemblies as directed below, crank the table all the way to the right or left in order to be able to position the lift table next to the machine.

1. Remove the left and right bearing assemblies. Save the parts removed from the right side for use in installing the X-Axis ball screw.

Note: If the machine has a power feed on the right end, save the left end assembly to mount later to the right end.

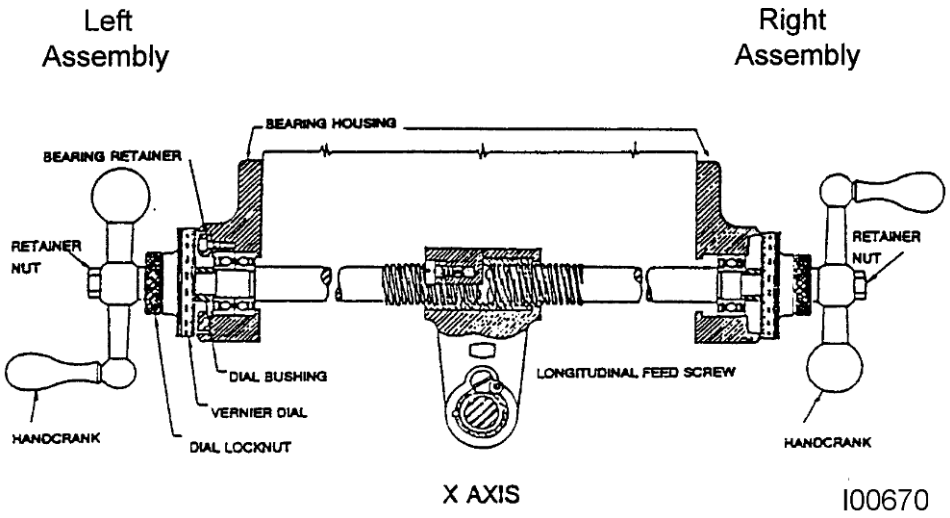


Figure 46
X Leadscrew Assembly

2. Center the table and remove the X gib.

3. Slide the machine's table onto a lift table and move it away from the machine.

CAUTION!
When removing the table, make sure it does not cock or it may break the dovetails as it slides out.

4 . Crank the saddle all the way forward and remove the Y-axis bearing assembly. Save the vernier dial for use with the Y-axis ball screw.

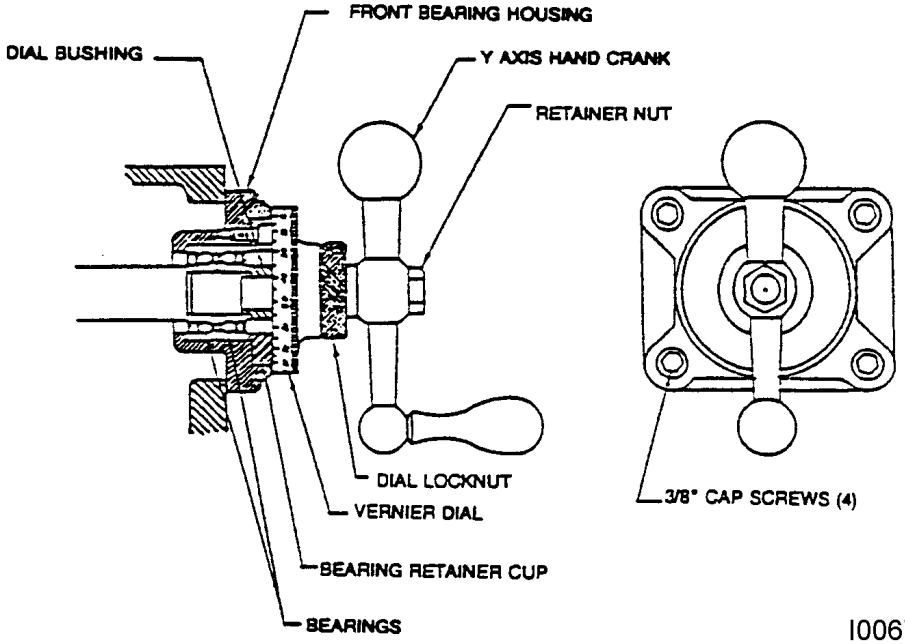


Figure 47
Y Leadscrew Assembly

5. Remove the X and Y leadscrews.

Note: to remove a leadscrew, remove the nut retaining screw and slide the brass acme nut and the leadscrew out of the yoke together.

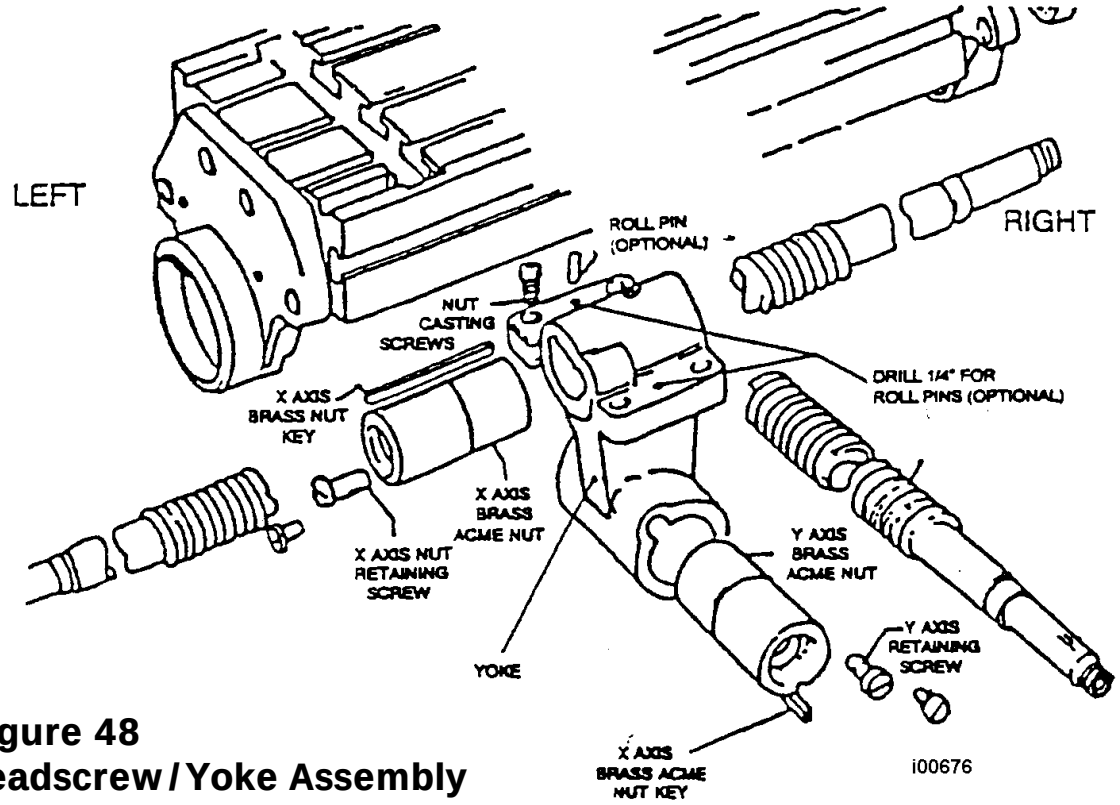


Figure 48
Leadscrew / Yoke Assembly

6. Remove the yoke from the saddle. Disconnect the oil lines from the yoke. If the yoke is to be re-used, it will be necessary to remove the brass nut key and pins. If the kit came with a yoke, the original yoke may be discarded.

7. Clean the X and Y-axis gibs, oil grooves and slideways thoroughly. Also remove the sliding covers and clean them. Inspect the operation of the oiling system.

Note: Step 7 is worth extra care, especially with machines that have some wear, or new machines that may have some protective covering on the ways. System performance depends on smooth motion.

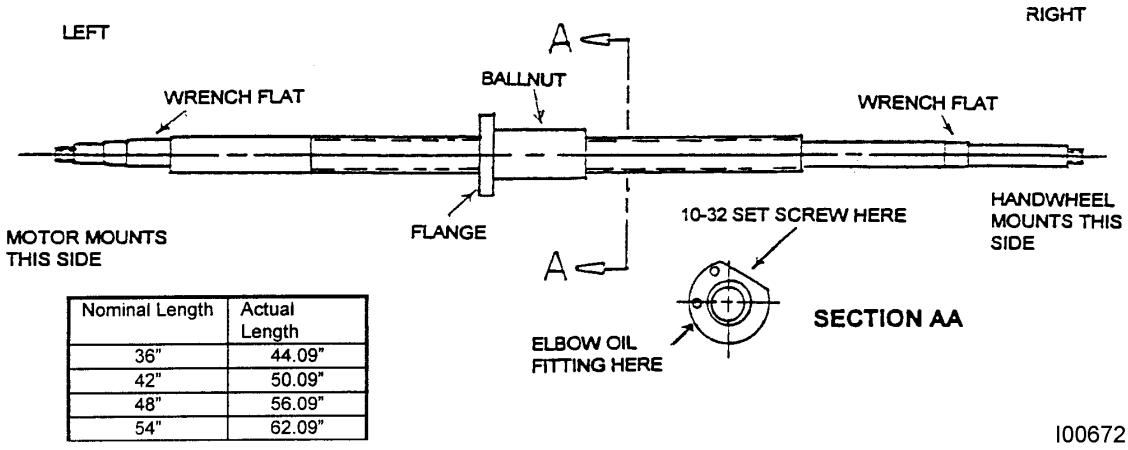
7.1.2 X-Axis Ball Screw Installation - Part 1

The ball screws are to be installed in the following order:

- First - part of the X-axis ball screw assembly.
- Second - the entire Y-axis ball screw assembly.
- Third - the rest of the X-axis ball screw assembly.

Parts required:

- Yoke kit 15844-xx
- X-Axis drive kit 20255 -xx
- X-Axis ball screw



Nominal Length	Actual Length
36"	44.09"
42"	50.09"
48"	56.09"
54"	62.09"

Figure 49
X-Axis Ball Screw

Note: There are wrench flats on the X and Y ballscrews for convenience.

CAUTION!
Unlike a leadscrew, never unscrew a ball screw from its nut.
This will destroy the ball screw.

8. Position the yoke in the saddle with the threaded hole on the left. Do not secure the yoke to the saddle yet, you will need to lift the yoke to slide in the ball screw.

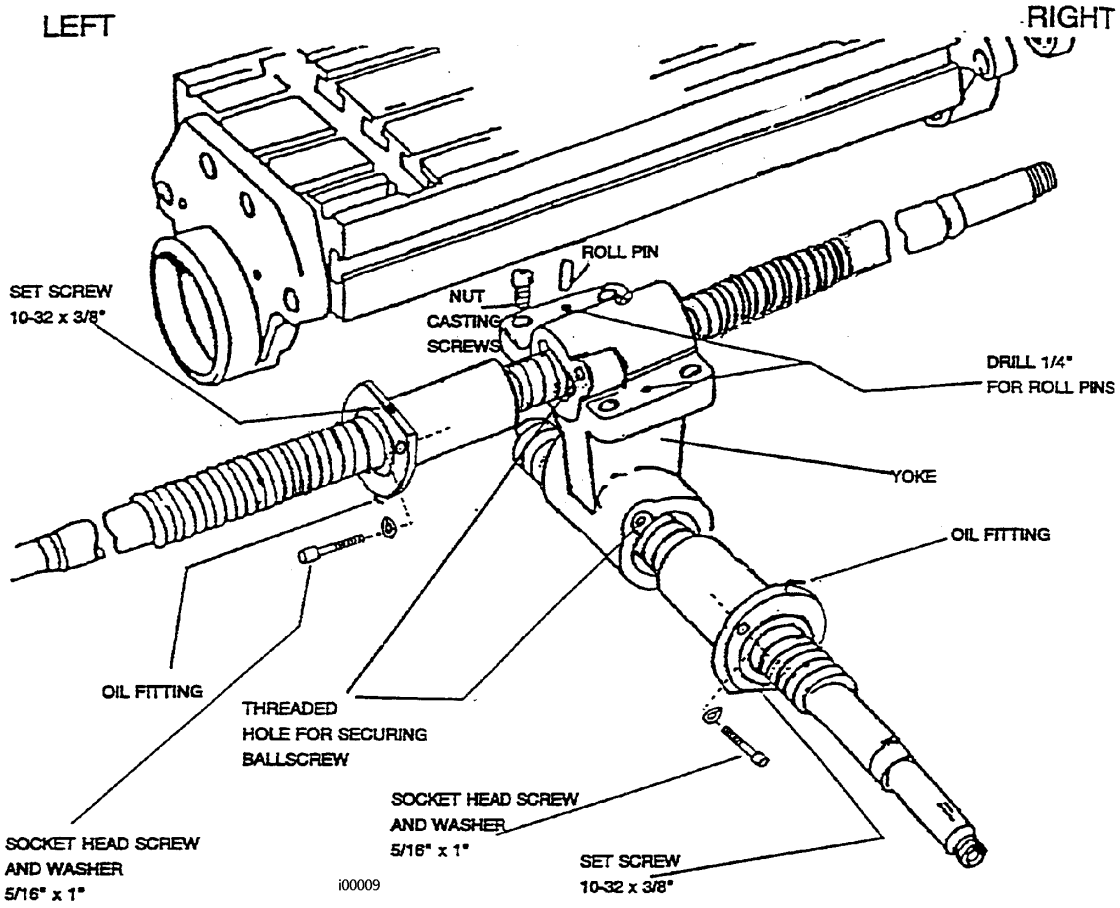
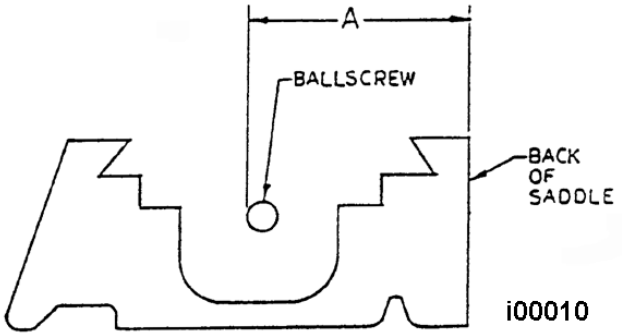


Figure 50
Ball Screw/Yoke Assembly

9. In the ballnut flange there are two tapped 10-32 holes. One for the provided elbow oil fitting, and one for a 10-32 setscrew. For the X ball screw put the elbow oil fitting in the hole on the radius of the flange, and the setscrew in the hole on the flat. The function of the setscrew is only to prevent oil from flowing out of the ballnut. Screw it as far as possible being careful not to contact and deform the nylon wiper.
10. Attach the provided plastic oil line to the elbow oil fitting.
11. Slide the ball screw into the yoke with the flange of the ballnut to the left. Do not install the 5/16-18 x 1 3/4" screw yet.
12. Secure the yoke to the saddle with the 4 screws, make it snug but not tight. You will need to move the yoke a little to align the ball screw.
13. Secure the ballnut to the yoke with 5/16-18 x 1 3/4" screws.
14. (Optional) If the yoke was pinned previously, replace the pins and then tighten the yoke to the saddle.
15. If the yoke was not pinned, it will be necessary to align the ball screw:



Take measurement "A" on the left and right sides of the saddle casting. So that the measurements are comparable, measure from the OD of the thread of the ballscrew on both sides.

Note: If the back of the saddle casting is not a suitable reference, it may be necessary to position a piece of round stock inside the back dovetail to be used as a reference point.

Adjust the position of the yoke until the two measurements are within 0.005" end to end (maximum).

CAUTION!
The alignment of the ballscrew is crucial.
Misalignment can cause damage to the ballscrews and drive assemblies as well as poor system performance.

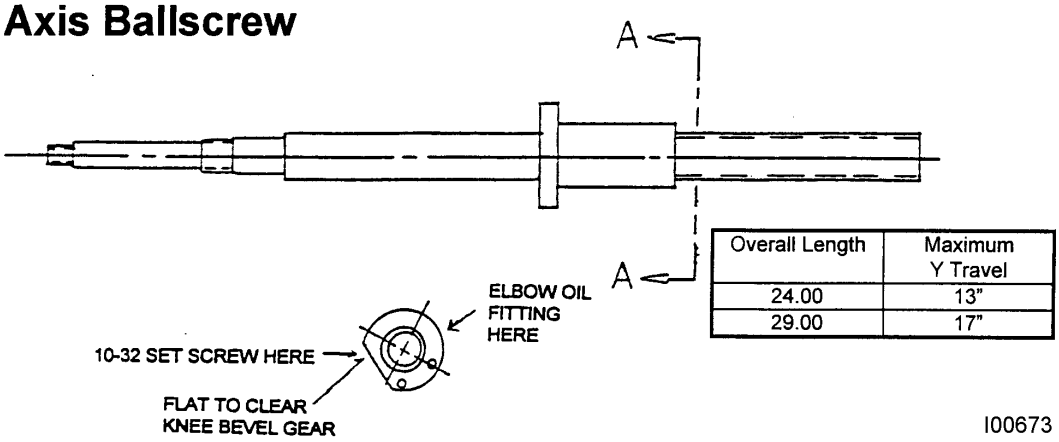
16. Tighten the yoke to the saddle casting. Check the alignment again to be sure the yoke did not move as it was tightened. Pin the yoke in position using the provided roll pin.

7.1.3 Y-Axis Ball Screw Installation

Parts required

- Yoke kit (already opened)
- Y-Axis drive assembly 23083-xx
- Y-Axis ball screw

Figure 51
Y Axis Ballscrew



Overall Length	Maximum Y Travel
24.00	13"
29.00	17"

CAUTION!
Unlike a leadscrew never unscrew a ball screw from its nut.
This will destroy the ball screw.

17. In the Y-axis ball screw, put the 10-32 set screw in the hole on flat part of the ballnut flange and the elbow oil fitting in the hole on the radius.

18. Attach the provided plastic oil line to the elbow oil fitting.

19. Pull the saddle all the way forward and install the ball screw into the yoke with 5/16-18 x 1 3/4" screws. The flat of the ballnut flange should match up with the flat on

the yoke. These flats are there so that the yoke and ballnut will clear the bevel gear. Check that these clear now by pushing the saddle back.

If the yoke provided in the kit does not clear the bevel gear, it will be necessary to remove enough material from it so that it will clear.

Also check that the elbow fitting will clear the casting at the top front of the knee. If it interferes, it will be necessary to screw it down more, or grind away the casting to clear.

20. Route the oil line up through the hole in the saddle to the right rear of the yoke, trim it appropriately and attach it to one of the oil lines of the machine.

(*Kit Variation: some machines do not have separate oil lines running to each leadscrew. Use the supplied T fitting to route oil to each ball screw.)*

CAUTION!
Make sure that the oil line will not be sheared by the sliding covers when the saddle moves.

(Kit Variation: on machines with oil restrictors on the yoke, use the supplied brass fitting and the original restrictor.)

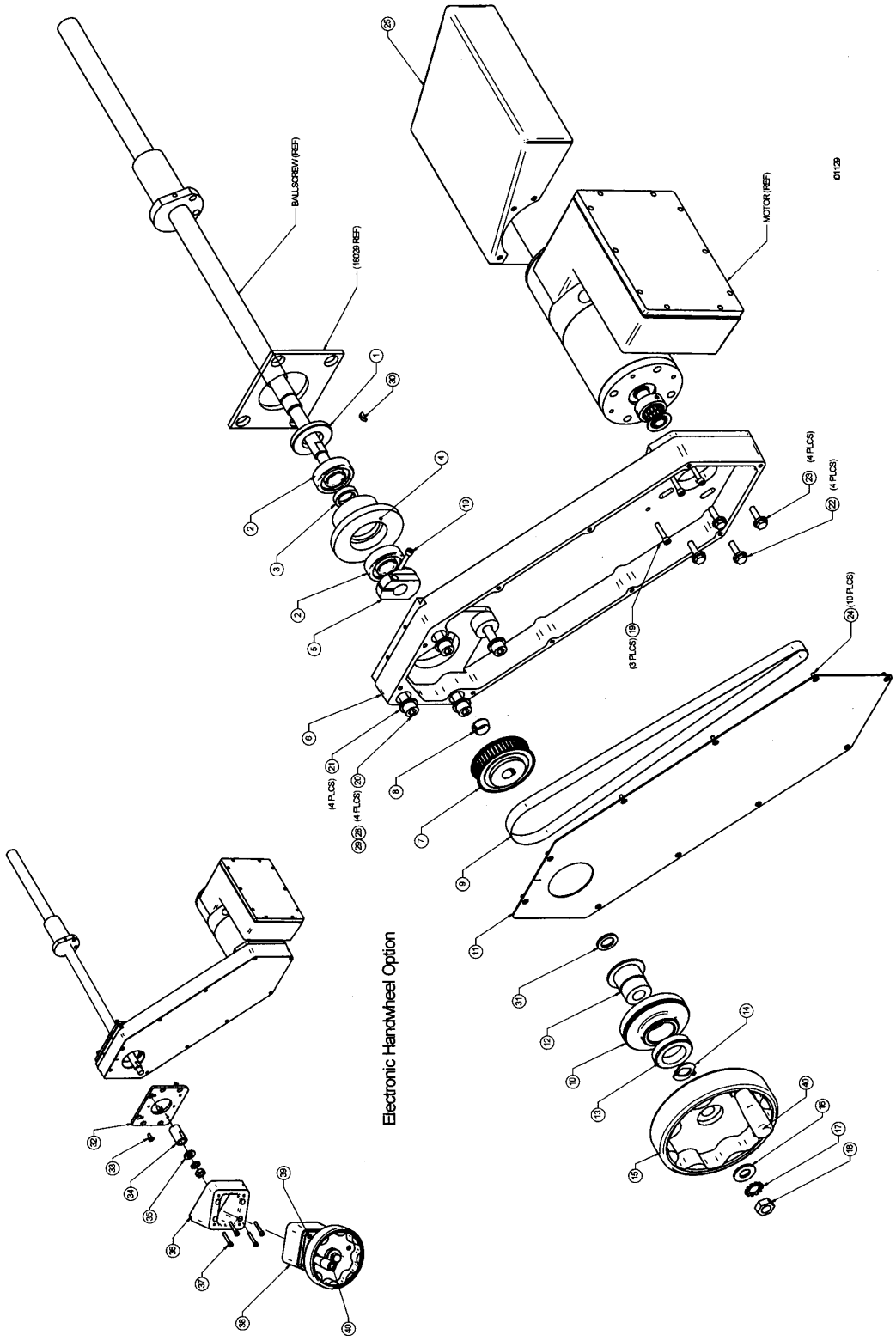


Figure 52 - Y-Axis Drive Assembly

Y-Axis Drive Assembly Parts List

i00912

Item	P/N	Description	Qty
1	15626	SEAL-BEARING HOUSING	1
2	23930	BEARING SET-ANGULAR CONTACT- 7204 BECBP	1
3	15885	RING-BEARING HOUSING	1
4	15980	BEARING HOUSING	1
5	16452	NUT CLAMP-X ,Y, & Z AXIS	1
6	20623	MOTOR BRACKET-KNEE MILLS-40 DEGR	1
7	16983-1	PULLEY-SOLID 44 TEETH W/O GUIDES	1
8	16350	FERRULE-SPROCKET	1
9	890-5M-15	BELT - TIMING 5MM POWERGRIP (Y AXIS)	1
10	16533	VERNIER DIAL-PT4	1
11	20621	COVER-SPORT 40 DEGREE	1
12	15627-2	DIAL HOLDER	1
13	15836	DIAL NUT	1
14	15614	TAB WASHER	1
15	15616	HANDWHEEL ASSY-MX	1
16	1/2 71Z	WASHER-FLAT SAE-STL-ZINC	1
17	1/2 75Z	WASHER-EXT TOOTH-STL-ZINC	1
18	1/2-20 51Z	NUT-HEX JAM-STL-ZINC	1
19	10-32X1 25B	SCREW-SHCS-STL-BO	4
20	M10-1.5X65 25B	SCREW-SHCS-STL-BO	4
21	23082	WASHER-.75X.394X.10-STL	4
22	1/4-20X1 24B	SCREW-HEX HD-STL-BO	4
23	15759	WASHER-1/4 HARD BLK OX 1/8 THK	4
24	6-32X3/8 10B	SCREW-PH-PHIL-STL-BO	10
25	23141	SHEET METAL-PT4-COOLANT MOTOR COVER ASSY	1
26	10-32X3/8 10B	SCREW-PH-PHIL-STL-BO	3
27	10 73B	WASHER-SPLIT LOCK-STL-BO	3
28	30922	HANDLE FOLD-A-WAY	1
30	98481A090	KEY WOODRUFF #404-1/8 X 1/2	1
31	14772-2	SPACER - .020" THICK	1
	20296R	MOTOR ASSY	1
	15609-12	Y BALLSCREW – K2	1
	15609-16	Y BALLSCREW – K3/K4	1

Y-Axis Electronic Handwheel Option Parts List

Item	P/N	Description	Qty
32	21984	BRACKET-WAY COVER FRONT Y-AXIS DRIVE	1
33	¼-20X5/8 26B	SCREW-FHCS-STL-BO	2
34	21992-1	BUSHING-BALL SCREW (Y-AXIS)	1
35	14772	SPACER-.100” THICK	1
36	21985	SPACER-30 DEGREES Y-AXIS	1
37	M6-1.0X25 25B	SCREW-SHCS-STL-BO	4
38	21946	ELECTRONIC HANDWHEEL	1
39	M6-1.0X75 25B	SCREW-SHCS-STL-BO	4
40	25729	HANDLE REPLACEMENT KIT	1

21. Place the bearing housing on a flat surface and install the following as shown below:

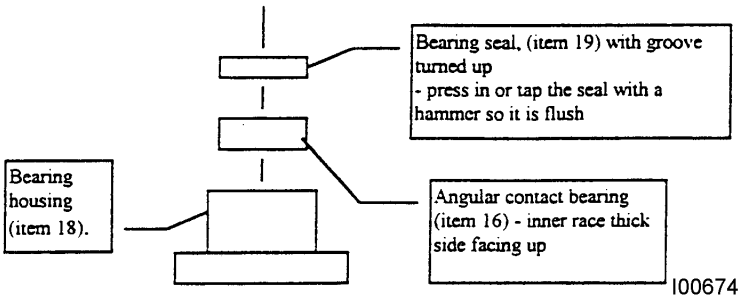

Bearing seal, (item 19) with groove turned up
- press in or tap the seal with a hammer so it is flush
Bearing housing (item 18).
Angular contact bearing (item 16) - inner race thick side facing up
I00674

Figure 53
Bearing Housing

22. With the saddle all the way forward, install the assembly from the previous step on the ball screw with the bearing seal towards the machine.

(Kit Variation: the Y-Axis bearing housing is designed to float to find its own center. For some machines, the hole in the knee is too large for the flange of the bearing housing to contact. Use the supplied backing plate shown below.)

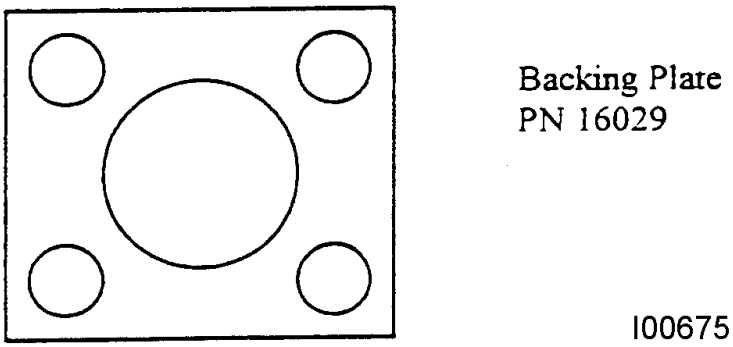


Figure 54
Backing Plate

23. Install the bearing housing A on the ballscrews as shown in Figure 53. The angular contact bearing should have the inner race, thin side in.

24. Install the clamp nut and torque to 50 ft/lb. Tighten the 10-32 x 3/4" screw on the clamp nut.

Note: To keep the clamp nut from expanding while using the torque wrench, put in and snug the 10-32 x 3/4 setscrew. Tighten the cap screw after proper torque is obtained.

25. Turn the clamp nut until the flange of the bearing housing contacts the knee (or backing plate, if one is used) and the saddle begins to move forward.

26. Install the Y motor mounting bracket. This bracket can vary from machine to machine.

27. Install the remaining items on Figure 52.

28. Hang the timing belt over the pulley now.

29. Install the top cover of the motor mounting bracket and check for clearance between the vernier dial and the cover. If the dial rubs, add shims to the vernier dial holder.

    Note: Sometimes it will be necessary to use the shims from the original X-axis hardware.

30. Tighten the 1/2 - 20 hex nut to 50 ft/lb. Move the saddle back and forth through full travel to inspect for smoothness.

7.1.4 X-Axis Ball Screw Installation - Part 2

CAUTION!
Unlike a leadscrew never unscrew a ball screw from its nut.
This will destroy the ball screw.

31. Attach the X-Axis ball screw oil line. Liberally lubricate all way surfaces.

32. Screw the X-Axis ball screw out of the way and remount the table. Oil and reinstall the X gib.

CAUTION!
Make sure the gib locks have not fallen into the saddle
before you slide the table back on.

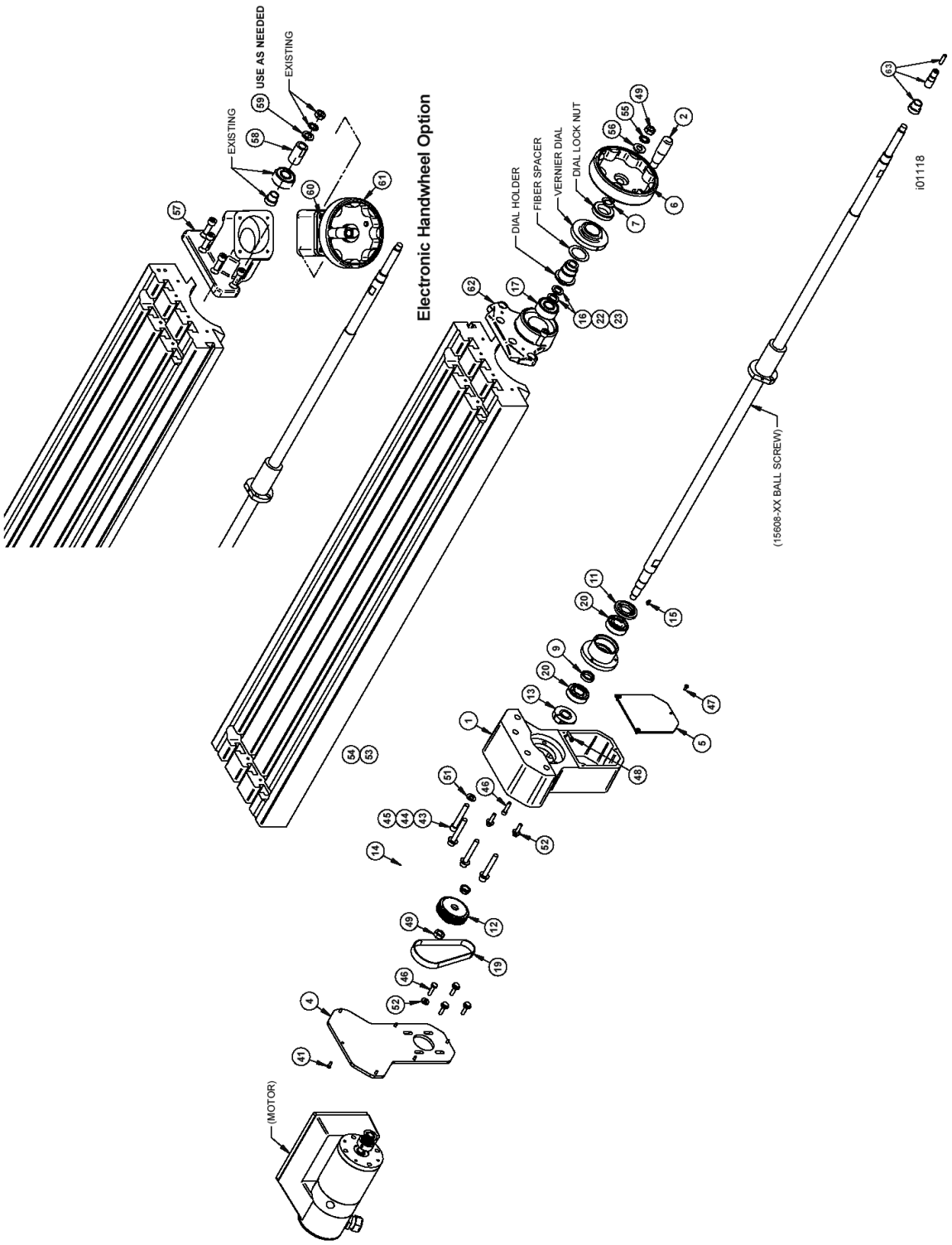


Figure 55
X-Axis Drive Assembly

X-Axis Drive Assembly Parts List

Item	P/N	Title	Qty
1	15621	DRIVE HOUSING	1
2	25729	HANDLE REPLACEMENT KIT	1
4	15624	FRONT COVER	1
5	15622	BACK COVER	1
6	15616	HANDWHEEL ASSY-MX	1
8	15612	HOUSING - BEARING	1
9	15885	RING-BEARING HOUSING	1
10	15638	STOP - X-AXIS (not shown on drawing)	1
11	15626	SEAL-BEARING HOUSING	1
12	16983-1	PULLEY-SOLID 44 TEETH W/O GUIDES	1
13	16452	NUT CLAMP-X ,Y, & Z AXIS	1
14	16350	FERRULE-SPROCKET	1
15	98481A090	KEY WOODRUFF #404-1/8 X 1/2	1
16	14772	SPACER - .100" THICK	5
17	22008	BEARING- 204KTT	1
19	400-5M-15	BELT - TIMING 5MM POWERGRIP	1
20	23930	BEARING-ANGULAR CONTACT- 7204 BECBP	SET
22	14772-2	SPACER - .020" THICK	2
23	14772-5	SPACER - .050" THICK	2
41	8-32X3/8 25B	SCREW-SHCS-STL-BO	6
42	5/16-18X1 25B	SCREW-SHCS-STL-BO	1
43	3/8-16X2 1/2 25B	SCREW-SHCS-STL-BO	4
44	M8-1.25X65 25B	SCREW-SHCS-STL-BO	4
45	M10-1.5X65 25B	SCREW-SHCS-STL-BO	4
46	1/4-20X1 24B	SCREW-HEX HD-STL-BO	7
47	8-32X3/8 20B	SCREW-RH-PHIL-STL-BO	3
48	10-32X3/4 25B	SCREW-SHCS-STL-BO	1
49	1/2-20 51Z	NUT-HEX JAM-STL-ZINC	2
51	M8 70P	WASHER-FLAT USS-STL-PLAIN	4
52	15759	WASHER-1/4 HARD BLK OX 1/8 THK	7
53	3/8 70P	WASHER-FLAT USS-STL-PLAIN	4
54	M10 70P	WASHER-FLAT USS-STL-PLAIN	4
55	1/2 73B	WASHER-SPLIT LOCK-STL-BO	1
56	1/2 70P	WASHER-FLAT USS-STL-PLAIN	1
62	22007	END CAP	1
63	15181	BALLSCREW EXTENSION	1
	15608-48	BALLSCREW - X AXIS	1

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X-Axis Electronic Handwheel Option Parts List

Item	P/N	Description	Qty
57	22718	SPACER-45 DEGREES X-AXIS	1
58	21992	BUSHING-BALLSCREW (X-AXIS)	1
59	14772	SPACER-.100” THICK	1
60	M6-1.0X75 25B	SCREW-SHCS-STL-BO	4
61	21946	ELECTRONIC HANDWHEEL	1

33. Install the left end assembly items as shown in Figure 55.

34. Slide the table so that the left end of the table is approximately over the left end of the ball screw and install the drive housing onto the table with the four 3/8 -16 x 2 1/2" socket head cap screws.

35. Slide the table to the right and secure the drive housing bracket to the bearing housing per Figure 55.

36. Install the rest of the items of Figure 55 and tighten 1/2-20 nut to 50 ft/lb.

37. Screw the ball screw so that the table is positioned with the right side of table almost flush with the right edge of the saddle.

    Note: Temporarily install the 1/2 - 20 nut on the right of the ball screw and use this to turn the ball screw.

38. Install the original machine right side assembly and the SWI provided handwheel as per Figure 55.Tighten 1/2-20 nut to 50 ft/lb. (If the machine had a power feed, use the hardware from the left side).

    Note: if the ball screw requires a ball screw extension see Step 39 - "Installing ball screw extensions". Otherwise go to Step 40.

39. Ball screw Extension Installation
    1. Slide bushing onto end of ball screw.
    2. Screw threaded extension snugly onto ball screw.
    3. Tighten setscrew (inside of threaded extension) finger-tight.
    4. Back off the threaded extension 1/16 of a turn.
    5. Tighten setscrew.
    6. Using two wrenches, tighten the threaded extension to the ball screw.

    Note: The 6" extension uses a pin inside the threaded extension in addition to the setscrew.

40. Make a preliminary gib adjustment for each of the table and saddle gibs. Tighten the gibs until there is a noticeable drag on the table and saddle and then gradually loosen until the drag goes away and the motion is smooth again. There is additional information on gib adjustments in Section 5.

7.2 Motor/Servo Driver Installation

7.2.1 X-Axis Motor/Servo Driver Installation

Parts required:

- motor assembly 20296
- X drive assembly (opened in previous step)

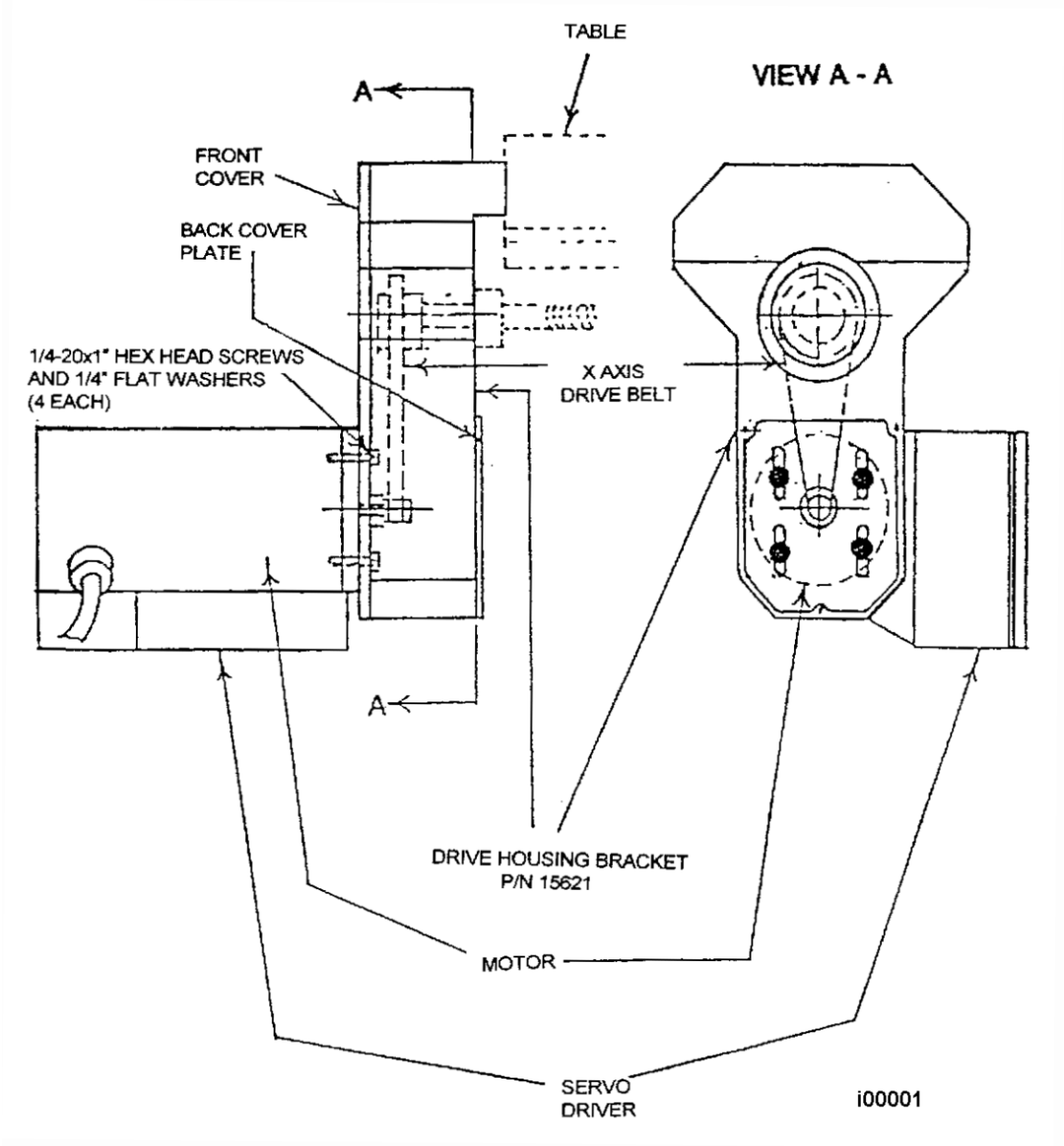


Figure 56
X Motor Mounting

1. Hang the belt on the pulley.

2. Install the front cover with the six 8-32 socket head screws.

3. Install the motor/servo driver assembly with the servo driver toward the rear of the machine. Install the motor so that there is very little play in the belt, a ¼ turn when twisting in the middle of the belt.

4. Install the back cover plate.

7.2.2 Y-Axis Motor and Servo Driver Installation

Parts required:

- Motor servo/driver 20296
- Y drive kit (opened in a previous step)

Note: Mount the assembly so that the servo driver is oriented toward the right, and the cable will be routed to the left of the machine.

1. Mount the motor on the motor mounting bracket. Tighten so that there is very little play in the belt, a ¼ turn when twisting in the middle of the belt.

Note: The belt should have been installed previously. Take extra care that the belt is seated on the pulley and is tight.

2. Install the bottom cover plate for the motor mounting bracket with the 10 Phillips head screws provided.

7.3 Pendant Installation

7.3.1 Pendant Arm Installation

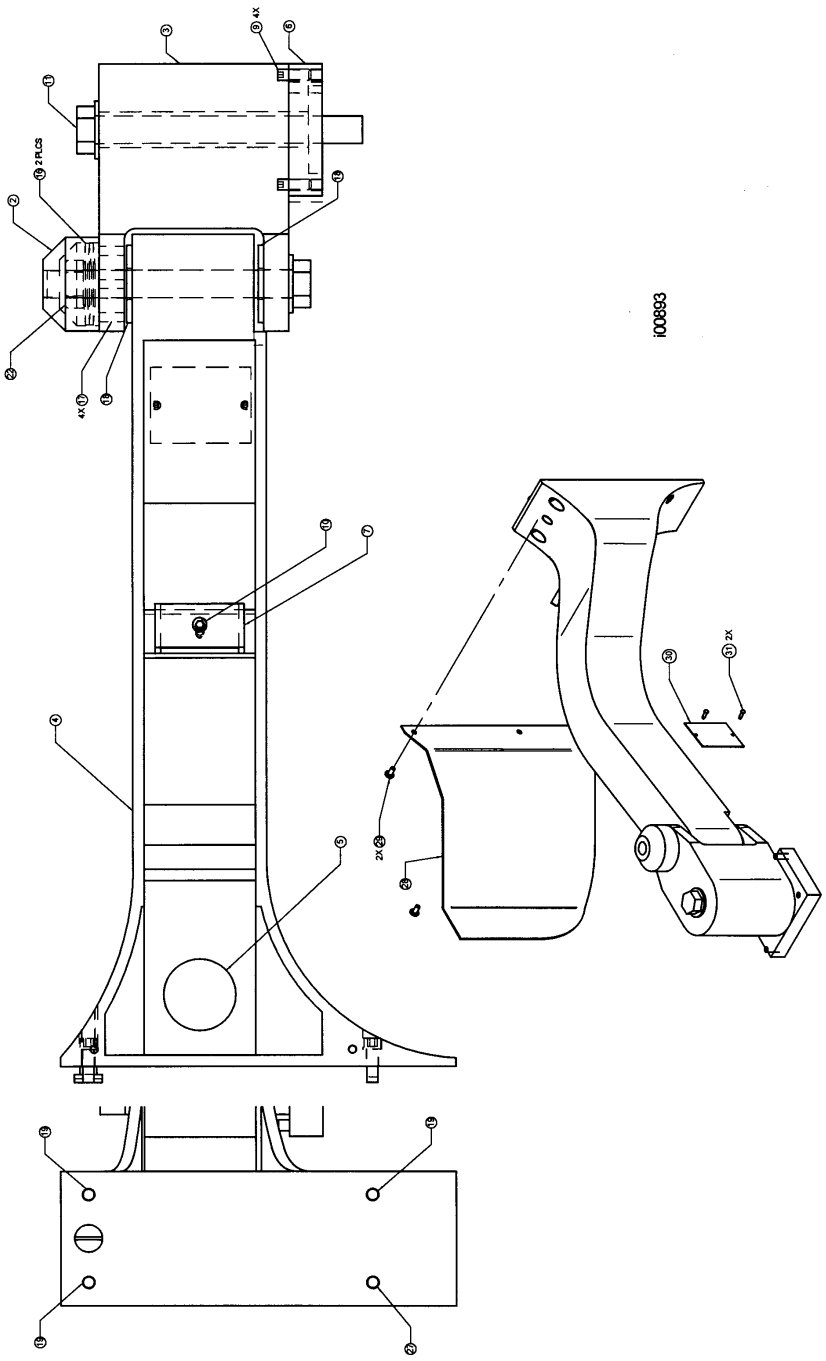


Figure 57
Pendant Arm Assembly

Pendant Arm Assembly Parts List

Item	P/N	Description	Qty
2	15896	PENDANT CUP	1
3	16797	RAM SUPPORT MACHINED	1
4	16738	PENDANT ARM MACHINED-M2/B5/SK2	1
5	20695	PLUG-SPORT E-STOP	1
6	16919	PLATE-LEVELING	1
7	16920	CLAMP - CABLE	1
9	1/4-20X3/4 40B	SCREW-SOC SET-STL-BO-CUP	4
10	10-32X1 1/4 25B	SCREW-SHCS-STL-BO	1
11	1/2-13X6 24P	SCREW-HEX HD-STL-PLAIN	1
16	9712K93	WASHER - BELLEVILLE	2
17	3/16X3/4 80P	PIN-DOWEL-STL-PLAIN	4
18	5/8 71P	WASHER-FLAT SAE-STL-PLAIN	2
19	1/4-20X3/4 25B	SCREW-SHCS-STL-BO	3
22	5/8-18 57Z	NUT-NYLON LOCK-JAM-STL-ZINC	1
27	1/4-20X5/8 25B	SCREW-SHCS-STL-BO	1
28	23139	SHEETMETAL-COVER-PENDANT ARM	1
29	10-32X3/8 31B	SCREW-PH-PHIL-EXT SEMS-STL-BO	2
30	21934	NAMEPLATE-EDGE S/N	1
31	#4 x 3/8 34J	SCREW-DRIVE	2

i00893

1. Prepare the assembly as shown in Figure 57.
2. Insert the two bellville washers (Item 16) opposing each other. They should create a hollow portion between the washers.
3. Tighten the nut to set tension on the arm. The arm should rotate freely with some resistance.
4. Assemble the ram support (Item 3) on the machine using the machine's lifting hook threaded hole. There are four different bolts provided to match the threaded hole. Use the cup point set screws to adjust the level of the plate.
5. Install the cap.
6. Install the cable clamp and cable cover.

7.3.2 Installation of the Pendant Display

1. Fasten the pendant onto the pendant arm using (4) ¼-20 x1" SHCS.
2. Install the cable cover to the pendant arm as shown in Figure 53 above.
3. Next route 3 cables down to the cable breakout box. One power cord and (2) 37 pin umbilical cables. Fasten cables to the pendant arm with the cable clamps provided. See Figure 12 for a description of cable routing.
4. Install the machine ID key to the LPT port on the pendant. The key can be found in the hardware kit.

7.4 Cable Breakout Box Mounting

The cable breakout box can come in 2 different configurations, one with auxiliary functions and one without. The physical size of the box is the same for both versions. The only difference is the 2 auxiliary ports found on the right side of the box. The auxiliary function box will have a 110 V outlet and a 4-pin amp connector to run an indexer. Mount the cable breakout box on the rear of the machine as shown in Figure 4 in Section 2. It will mount with the use of (3) M6 x 20 SHCS. You may need to add washers to the back of the box to offset it from the machine it case of casting interference.

7.5 Z-Axis Glass Scale Installation

See Figure 58.

1. Check the tram of the head in the X direction. If it is within a few thousands then continue on. If not tram.
2. Mount the upper mounting bracket loosely to the upper mounting surface of the head with a 10-32 cap screw.
3. Mount the lower mounting bracket loosely to the lower mounting surface of the head with a 10-32 cap screw.

> **Caution!**
> Do not drill through the threaded quill stop rod.

4. Install the 2 each, 6-32 leveling screws to each mounting bracket.
5. Mount the scale loosely to the mounting brackets with a 1/4-20x 1/2" bhcs and M6 washer.
6. Indicate the front of the scale and the right side of the scale to within .005" over the travel of the quill. Tighten the bracket mounting screws and use the leveling screws to adjust the alignment.
7. Mount the readerhead bracket to the quill stop knob with the pin and 1/4-20x 1" shcs.
8. Remove the readerhead cover plate and position the readerhead bracket so its holes line up with the holes in the readerhead. Use shims as necessary between the pin and bracket if the holes do not line up side-to-side with the readerhead holes. There should be a gap of 0.030"-0.180" between the readerhead and bracket.

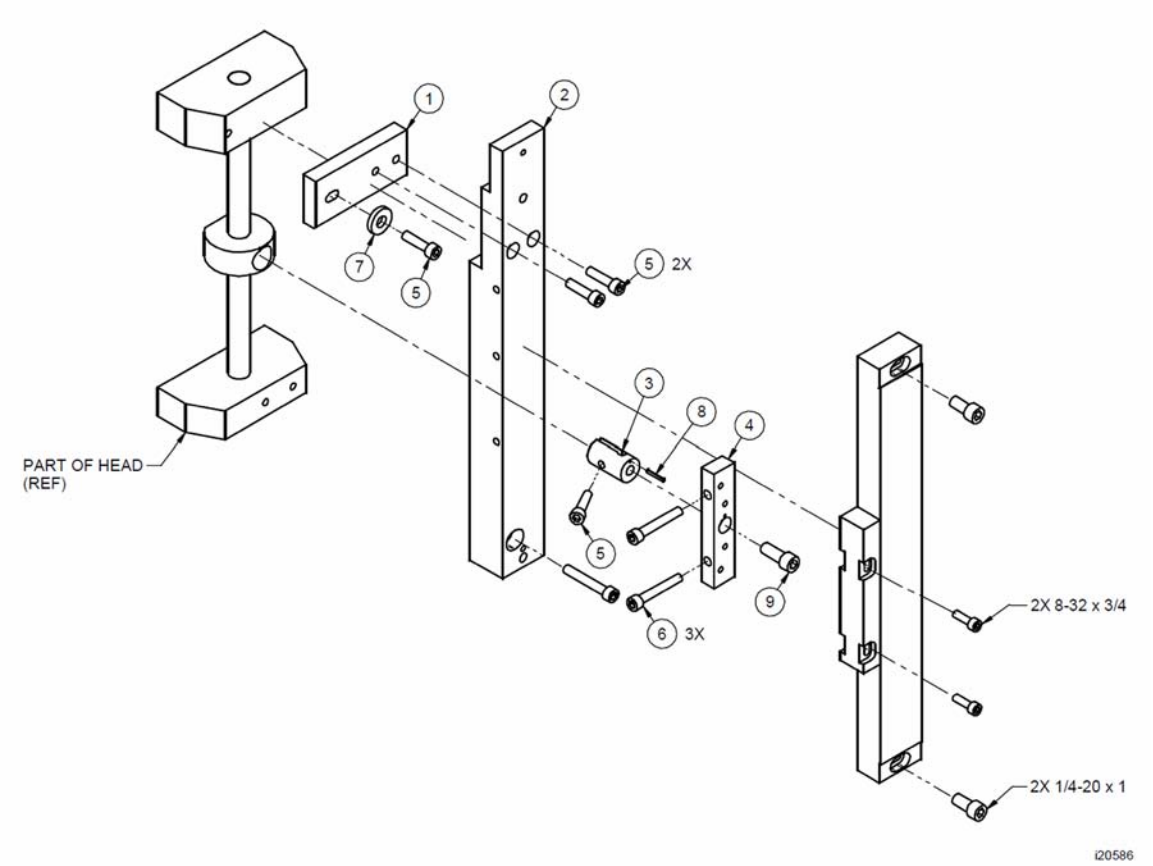
   Kit Variation: some scale brackets require the transfer of the hole pattern of the readerhead to the readerhead bracket.

9. The rest of the scale installation is the same as the X-axis, Steps 5 through 7.

Key Notes:

1. Move the readerhead up and down the glass scale and make sure the gap is consistent between the readerhead and the glass scale. Tighten the screw to the quill stop knob.
2. Remove the red head securing plate.
3. If the gap is not consistent between the readerhead and the glass scale when moving the quill up and down then adjust the angle of the scale to make the gap consistent.

WARNING
The gap must be no larger than 0.060” between the readerhead and glass scale.



Part #	Description
22800-4	Z Glass Scale
20586	Bracket Assembly

Figure 58
Z-Axis Glass Scale Assembly

Item	P/N	Description	Qty
1	20550	ARM- Z-AXIS MOUNTING PLATE	1
2	20551	MOUNTING PLATE-Z-AXIS GLASS SCALE	1
3	20548	ADAPTER-Z-AXIS GLASS SCALE	1
4	20549	ADAPTER PLATE- Z-AXIS GLASS SCALE	1
5	10-32X3/4 25B	SCREW-SHCS-STL-BO	4
6	10-32X1 1/4 25B	SCREW-SHCS-STL-BO	3
7	15759	WASHER-1/4 HARD BLK OX 1/8 THK	1
8	1/16X1/2 81B	SPRING PIN	1
9	1/4-28X3/8 25B	SCREW-SHCS-STL-BO	1

7.6 TRAK Sensor Installation - Optional

See Section 5 of this manual for more sensor information.

Parts required:

- Sensor M250C
- X Y bracket kit, one of the following:

15926	16191
15927	15929
16105	

7.6.1 X and Y Axis Sensor

1. Install the brackets and run bar to the machine. The bracket should position the TRAK Sensor so that it is:

   - As low as possible on the back of the table
   - Does not run the gage wheel over the drain hole or any other existing holes in the table.
   - Does not run the gage wheel off the end of the table.
   - Clears the machine column when the saddle is cranked all the way back and the knee is lowered.

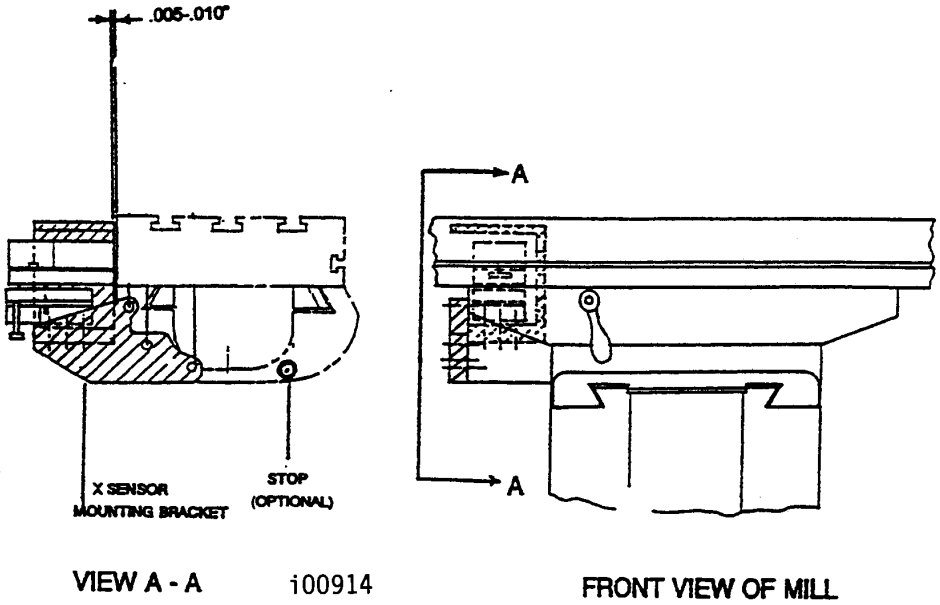


Figure 59
X Bracket Installation

Caution!
For the X-axis, make sure the drain tube is removed from the path of the TRAK Sensor. A crash of the sensor will break the Sensor or mounting base. Install the drain plug provided to discourage the re-attachment of the drain tube.

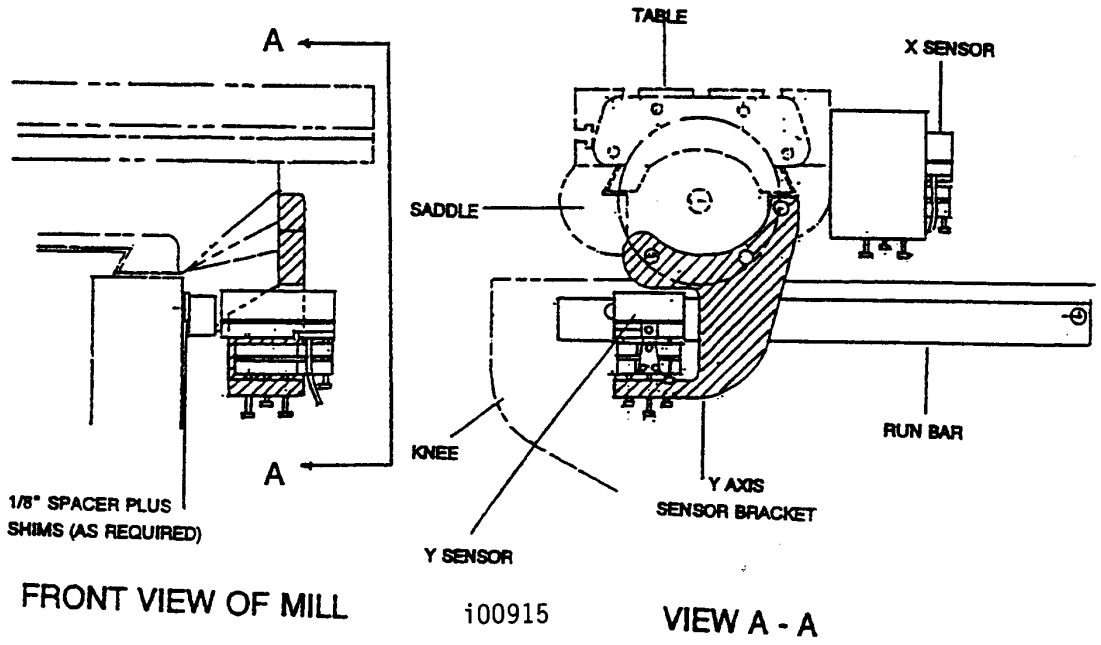


Figure 60
Y Bracket Installation

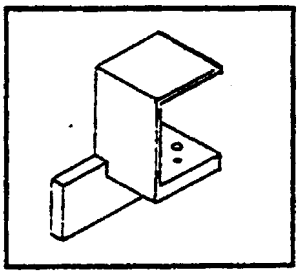
The Run Bar should be:

- Installed with 2 screws - minimum size 1/4 - 20
- Spaced from the knee appropriately to reach the sensor
- Free of twist
- Parallel to the saddle travel within 0.010”

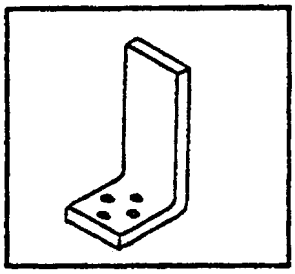
Note: Before installing the bracket, it is a good idea to assemble the bracket, mounting base and TRAK Sensor and hold the assembly against the planned mounting area.

Kit Variation: Figures 60 and 61 show the bracket that comes with the ProtoTRAK SMX 2-1 and other kits. Examples of other brackets and mountings are:

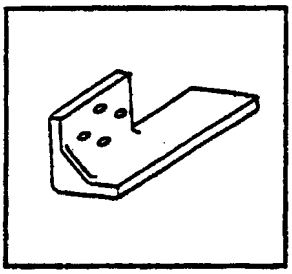
X BRACKETS



BR 17 MX
16023-1
Mount to back of saddle

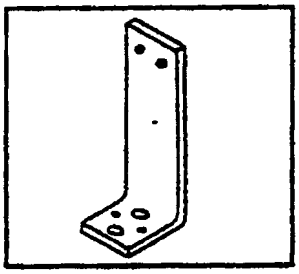


BR 17 (Universal)
Mount to back of saddle

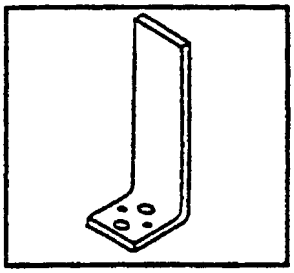


BR 17C (Universal)
Mount to side of saddle

Y BRACKETS



BR 48 TY
15127
Mount to front of saddle



BR 17 D-1
13384
(Universal)
Mount to front or back of saddle

i00913

Figure 61
Other X & Y Brackets Supplied with Kits

1. Install the M5 Base on the bracket. See Section 5.1.6.1, Figure 25.

   Parts required: M250C sensor and included hardware

   a) Put in pusher screws. These are the screws with the rounded ends.
   b) Position base and install puller screws and spherical washer sets. Use the pusher screws to square the M5 base to the running surface.
   c) Adjust the puller screws so that the raised bumps on the front of the base are parallel to the table.

   Note: The drawing shows a bubble level used for this adjustment. Alternatively, you may use a dial indicator set-up on the table.

2. Install the sensor on the M5 Base using the clamp screw. See Section 5.1.6.2, Figure 26.

3. Load the sensor against the running surface (table or run bar) using the load screw. The white lines on the side of the M5 base tell you when it is loaded correctly.

   Note: You want to load the gage wheel against the running surface using the flexure of the M5 Base. Do not tighten the clamp screw fully until after loading the sensor.

7.7 X and Y Glass Scale Installation - Optional

The Acu-Rite Glass Scales are shipped with complete installation instructions including illustrations. This section gives summary instructions for the installation of the glass scales on knee mills. If more instructions are needed, please see the booklet provided with the scales.

See Figure 29 in Section 5.

7.7.1 X Axis Scale Installation

Note: New Bridgeport machines have Acu-Rite scale mounting holes pre-drilled.

Caution!
If the scale is not long enough for the table, it will break when the machine is traversed past the scale travel.

1. With the table centered, position the scale and readerhead to make sure that the scale is the correct length. The readerhead mounting bracket is attached to the saddle and the scale is attached to the table.

2. Mount the readerhead mounting bracket to the saddle. Snug the screws, but do not tighten at this time, you will be making fine adjustments to the bracket's position after the scale is installed.

3. Mount the scale to the table:

   - Transfer the center hole first to use as a pivot point.
   - Align the scale so that it is within 0.005" end to end.
   - Transfer the holes on the ends and install the screws.
   - Re-check the alignment.

4. From the readerhead on the scale, remove the nameplate, shield and wires so that the mounting holes are accessible.

5. Attach the readerhead to the readerhead mounting bracket:

   - There are jackscrews on the readerhead to compensate for some gap between the readerhead and the readerhead mounting bracket.
   - Before tightening the readerhead to the bracket, there must be a .002 - .003" gap between the readerhead mounting bracket and the jackscrews. Tightening the mounting screws will eliminate this gap.

6. Replace the wires, shield and nameplate.

Caution!
Do not pinch the wires.

7. Remove the shipping brackets that fix the readerhead to the scale for shipping.

Caution!
After the readerhead is attached to the readerhead mounting bracket, do not move the machine axis until the shipping brackets are removed. This will break the readerhead.

7.7.2 Y Axis Scale Installation

1. Install the readerhead mounting bracket to the side of the saddle.

   Note: Once the readerhead mounting bracket is installed, position the scale and mounting spar assembly in position in order to determine the amount of spacers needed for the mounting spar. Also ensure that the scale is long enough for the saddle travel.

2. Transfer the mounting spar holes to the saddle and mount it.

   Note: the mounting spar must be parallel to the Y-axis travel within .005" end to end both horizontally and vertically. Use spacers and shims as necessary.

3. Slide the scale into the mounting spar and fasten.

   Note: the rest of the installation is the same as for the X-axis, Steps 5 through 7.

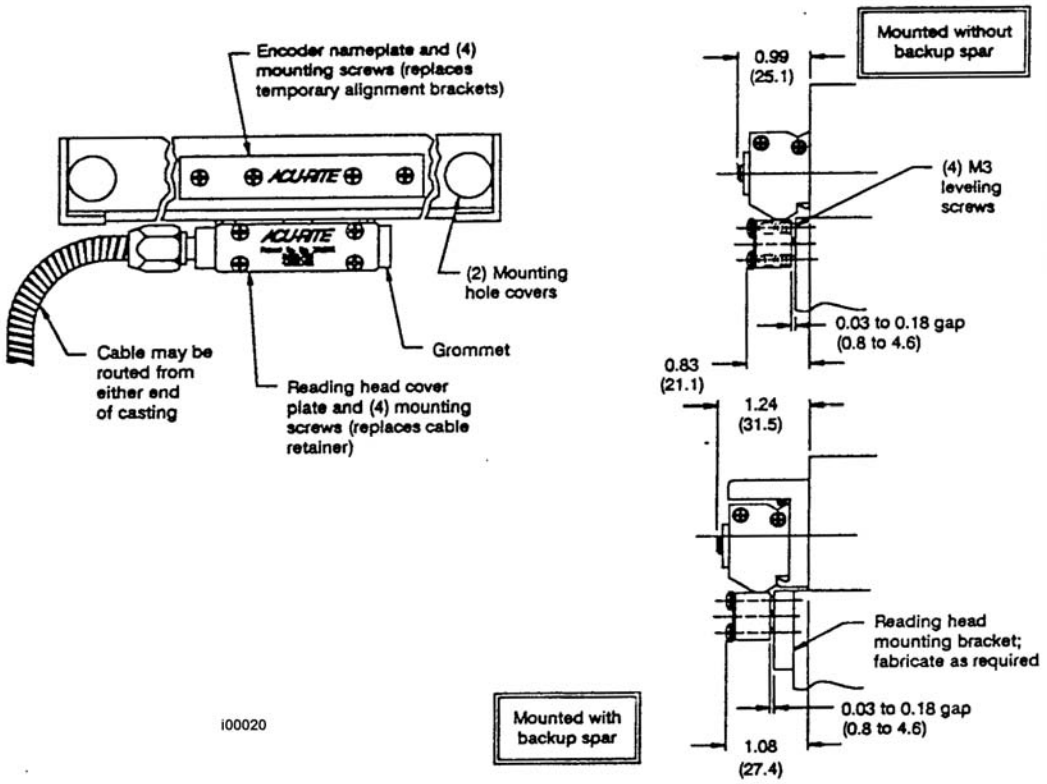

Encoder nameplate and (4) mounting screws (replaces temporary alignment brackets)
ACURITE
(2) Mounting hole covers
Grommet
Cable may be routed from either end of casting
Reading head cover plate and (4) mounting screws (replaces cable retainer)
i00020
Mounted without backup spar
0.99 (25.1)
(4) M3 leveling screws
0.03 to 0.18 gap (0.8 to 4.6)
0.83 (21.1)
1.24 (31.5)
Reading head mounting bracket; fabricate as required
0.03 to 0.18 gap (0.8 to 4.6)
1.08 (27.4)
Mounted with backup spar

Figure 62
Readerhead Mounting

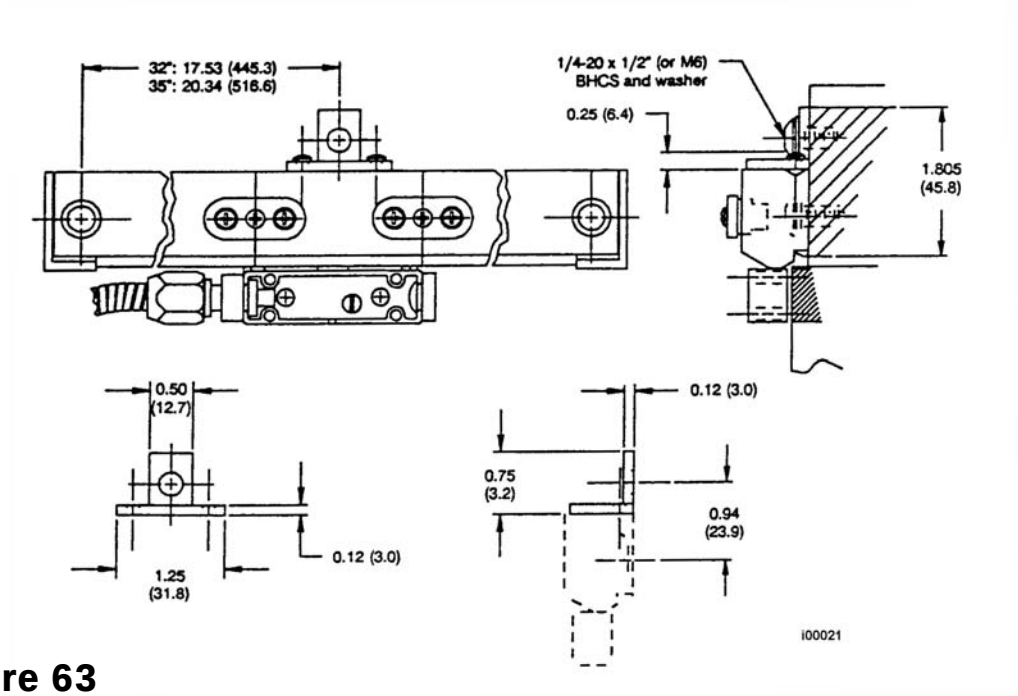


Figure 63
Scale Mounting

7.8 Limit Switch Installation Drawing

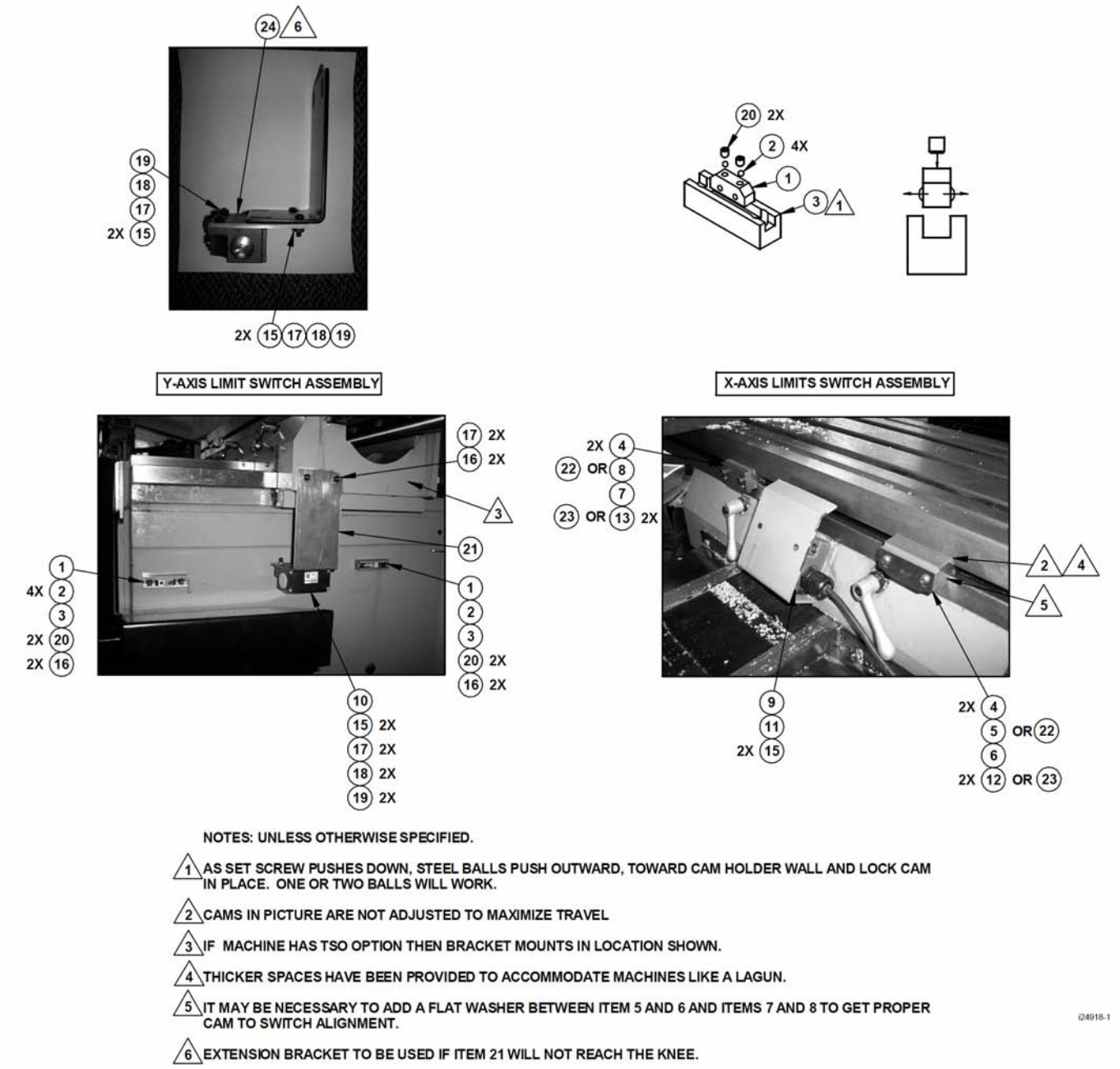


Figure 64
X & Y Limit Switch Assembly

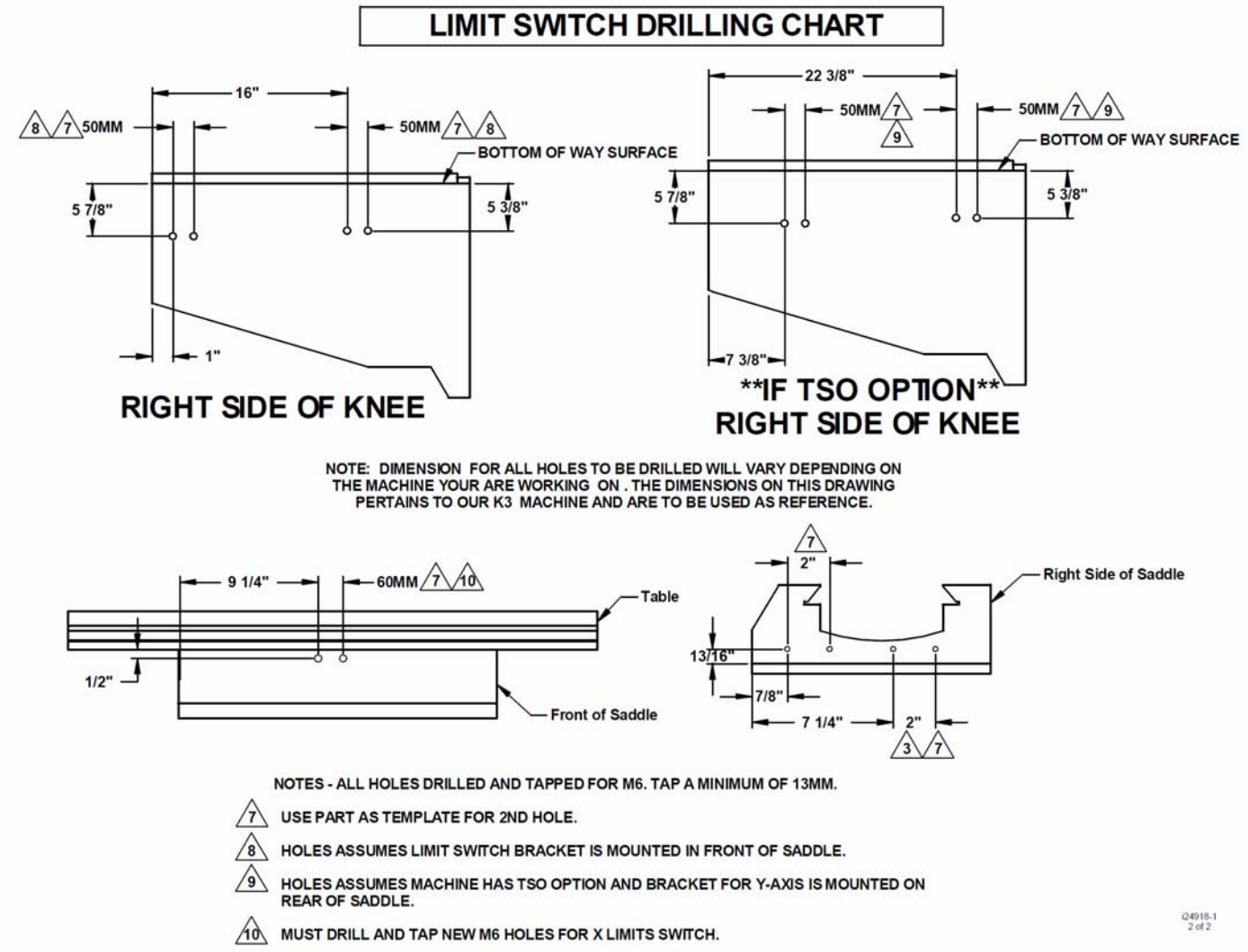

LIMIT SWITCH DRILLING CHART
16"
8 7 50MM
50MM 7 8
BOTTOM OF WAY SURFACE
5 7/8"
5 3/8"
1"
RIGHT SIDE OF KNEE
22 3/8"
50MM 7 9
50MM 7 9
BOTTOM OF WAY SURFACE
5 7/8"
5 3/8"
7 3/8"
IF TSO OPTION
RIGHT SIDE OF KNEE
NOTE: DIMENSION FOR ALL HOLES TO BE DRILLED WILL VARY DEPENDING ON THE MACHINE YOUR ARE WORKING ON . THE DIMENSIONS ON THIS DRAWING PERTAINS TO OUR K3 MACHINE AND ARE TO BE USED AS REFERENCE.
9 1/4"
60MM 7 10
Table
1/2"
Front of Saddle
7
2"
Right Side of Saddle
13/16"
7/8"
7 1/4"
2"
3 7
NOTES - ALL HOLES DRILLED AND TAPPED FOR M6. TAP A MINIMUM OF 13MM.
7 USE PART AS TEMPLATE FOR 2ND HOLE.
8 HOLES ASSUMES LIMIT SWITCH BRACKET IS MOUNTED IN FRONT OF SADDLE.
9 HOLES ASSUMES MACHINE HAS TSO OPTION AND BRACKET FOR Y-AXIS IS MOUNTED ON REAR OF SADDLE.
10 MUST DRILL AND TAP NEW M6 HOLES FOR X LIMITS SWITCH.
i24918-1
2 of 2

Figure 65
X & Y Limit Drilling Chart

Limit Switch Installation Drawing Part List

Item	P/N	Title	UseAs	Qty
1	22108	CAM-LIMIT SWITCH	EA	2
2	24920	BALLS - STAINLESS STEEL	EA	8
3	22547	CAM HOLDER-PT4-Y & Z AXIS	EA	2
4	22113	NUT TEE- X AXIS	EA	4
5	22438	SPACER-DPMV3-LIMIT SWITCH-RH	EA	1
6	22437	CAM-LIMIT SWITCH-RH	EA	1
7	22439	CAM-LIMIT SWITCH-LH	EA	2
8	22440	SPACER-DPMV3-LIMIT SWITCH-LH	EA	1
9	22551-1	LIMIT SWITCH ASSY-RIGHT	EA	1
10	22551-2	LIMIT SWITCH ASSY-LEFT	EA	1
11	22436-1	SHEET METAL - SUPPORT LIMIT SWITCH X-AXIS	EA	1
12	M6-1.0X40 27B	SCREW-BHCS-STL-BO	EA	2
13	M6-1.0X30 25B	SCREW-SHCS-STL-BO	EA	2
14	24918-1-DOC	LIMIT SWITCH KIT -RETROFIT (DWG)	EA	1
15	M6-1.0X25 25B	SCREW-SHCS-STL-BO	EA	6
16	M6-1.0X16 25B	SCREW-SHCS-STL-BO	EA	6
17	M6 70B	WASHER-FLAT USS-STL-BO	EA	20
18	M6 73B	WASHER-SPLIT LOCK-STL-BO	EA	8
19	M6-1.0 50B	NUT-HEX-STL-BO	EA	2
20	M5-0.8X6 40B	SCREW-SOC SET-STL-BO-CUP	EA	4
21	24922	BRACKET - Y LIMIT SWITCH	EA	1
22	24277	SPACER-LIMIT SWITCH	EA	2
23	M6-1.0X60 25B	SCREW-SHCS-STL-BO	EA	4
24	24278	BRACKET-EXTENSION	EA	1

i24918-1

7.9 System Interconnection

7.9.1 ProtoTRAK SMX Basic System Configuration

See Figure 15 and 16 for all system cable connections.

7.9.2 Cable Routing

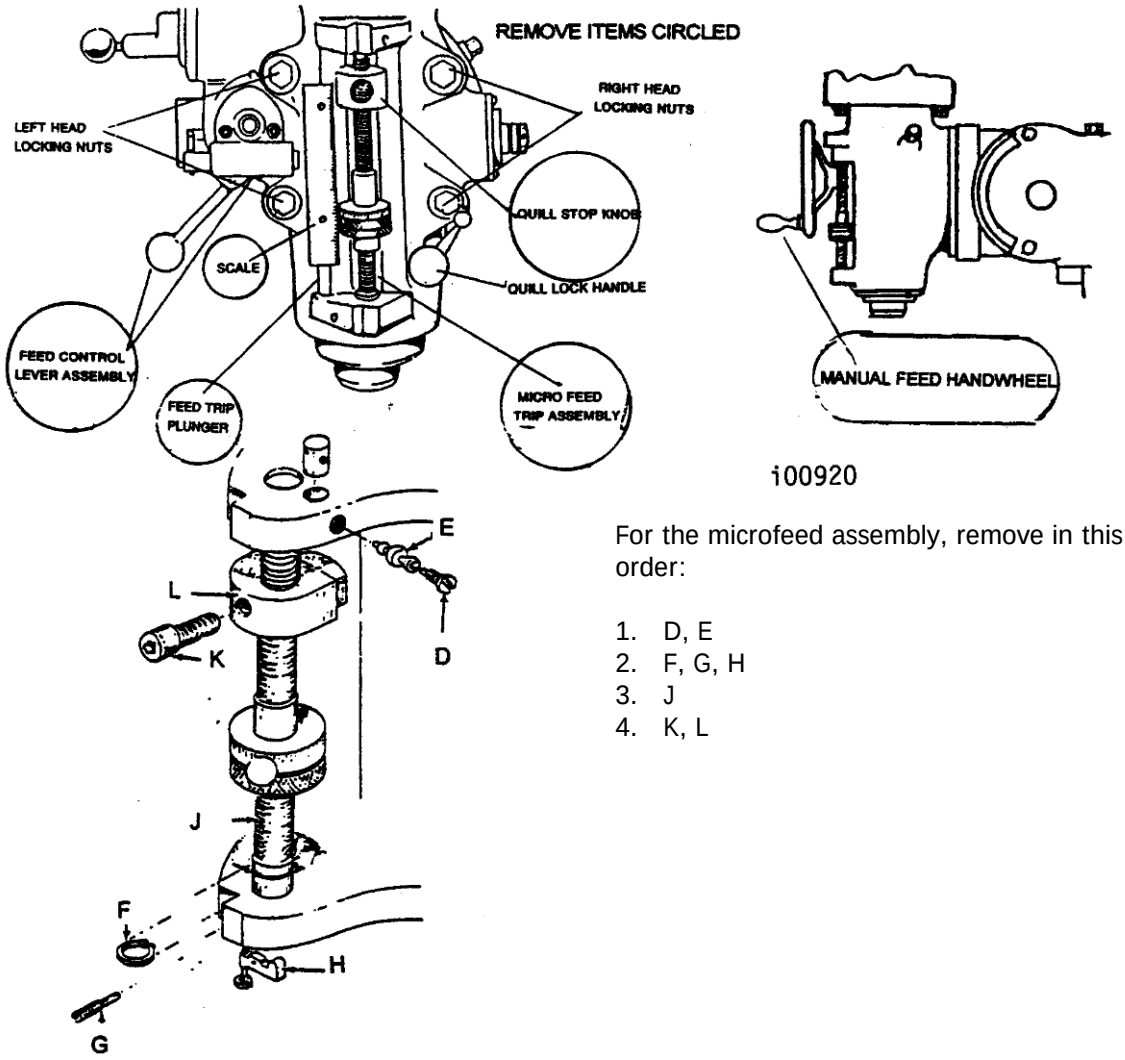
Tips for routing the cables on the machine.

- Before tying up cables, it is a good idea to position them loosely, complete the system interconnection and ensure that all the cables are plugged in correctly, and that the system is responding properly.
- Make sure that no motor cable is tied up next to a power line.
- Position the table all the way to the left and the saddle all the way forward before securing the X motor cables.
- Ensure the knee travel is not restricted.
- Do not bend umbilical cables. Coil up in a minimum of a 6” diameter.

8.0 Z Motor/Ball Screw Assembly

Note: This section is for the installation of ProtoTRAK SMX 3 axis controls only.
Note: Tram the head before beginning this procedure.

8.1 Installation of the Base Plate



For the microfeed assembly, remove in this order:

1. D, E
2. F, G, H
3. J
4. K, L

Figure 66

1. Remove the mill head assemblies indicated in Figure 66.

Caution!
After the quill stop knob is removed, take care that the quill is not allowed to fall out.

Kit Variation: For Lagun mills, substantial modification of the mill is required. See Fig 69

Note: Reposition the quill lock handle so that it is in the back. Once the baseplate is installed, it will be difficult to get to it.

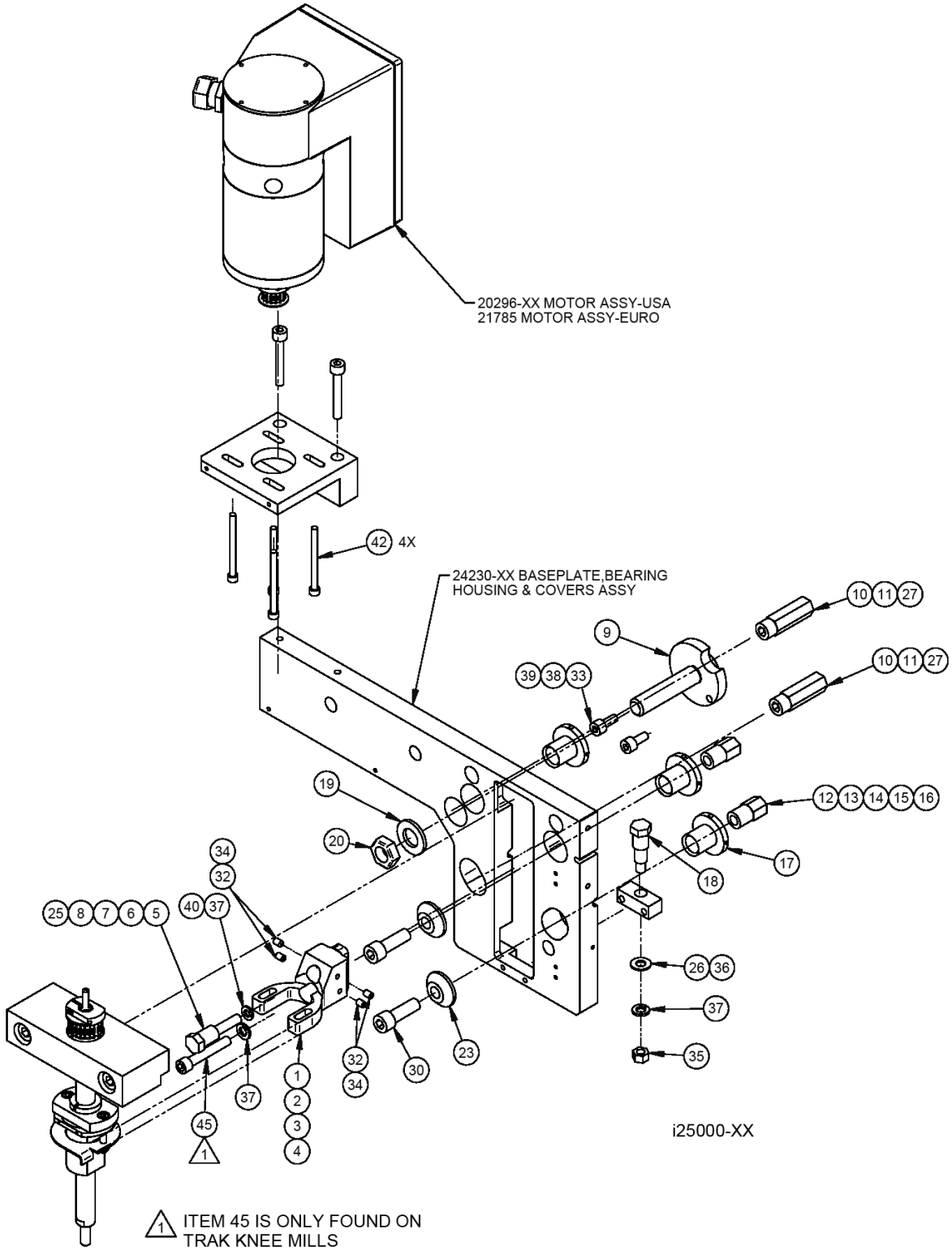


Figure 67 - Base Plate& Ball Screw Mounting

Note: Various components on Figure 67 have multiple balloons due to these parts varying on different machines.

Note: The overall strategy is:

- *The position locator (9), and the hex head screw (18) align the baseplate side to side.*
- *The leveling nuts (17) align the baseplate front to back.*

2. Replace the machine's head bolts with the Jackscrew nuts (items 12 through 16) on the right side. Replace the machine's head bolts with the socket head couplers on the left side. Items 12 through 16 vary depending on the type of head the kit is being installed on.
3. Tighten these incrementally to 50 ft/lb. or the mill manufacturer's spec for the head bolts.
4. Install the fork on the quill. Tighten to 25 ft/lb. Use locktite, a lockwasher and the setscrews provided. The forks vary from kit to kit.

> Caution!
> Do not over tighten the bolt; this may damage the bolt, the quill threads or deform the quill.

Note: The fork must move smoothly in the slot, otherwise it will have to be modified.

5. Install the position locator (Item 9) where the feed control was located.
6. Install the leveling nuts on the position locator and the jackscrew nuts.
7. Install the base plate with the hex head screw (Item 18) through the hole where the threaded rod used to be. Use shim between the block and baseplate if necessary.

   Note: for shipping, the ball screw and covers are mounted to the base plate. Remove them before installing the base plate.

8. Install the baseplate with the nut and washers as shown. Use the leveling nuts to align the baseplate to the travel of the quill front to back. Also, align the baseplate side to side by placing the level on the right edge of the baseplate and comparing it to the extended quill. Tighten the nuts to 25 - 35 ft/lb.

   Note: The baseplate must be parallel to the travel of the quill for the assembly to work properly. Use a bubble level on the quill to compare it to the front and side of the base plate. Check the alignment frequently, especially after installing and tightening the 1/2 - 13 x 1 1/2" socket screws (Item 30).

Parts List – Base Plate & Ball Screw Mounting

Item	P/N	Description	Use As	Qty
1	16215	BRACKET BALLNUT-MACHINED (FORK)	EA	1
2	16353-1	BRACKET BALLNUT MACHINED - ACER/MILLPORT	EA	1
4	16357-1	BRACKET BALLNUT FORK EXTENDED LAGUN SM16	EA	1
5	16355-1	SCREW 3/8-24 BRKT BALLNUT MOUNTING	EA	1
7	16364-1	SCREW M10-1.0 BRKT BALLNUT MOUNTING	EA	1
8	16364-2	SCREW M10 X 1.5 BRKT BALLNUT MOUNTING	EA	1
9	16210	POSITIONER LOCATOR	EA	1
10	16212-12	COUPLING SOCKET HEAD	EA	2
11	16212-13	COUPLING SOCKET HEAD	EA	2

12	16213-13	JACKSCREW NUT 1/2-13--1/2-13	EA	2
13	16213-12	JACKSCREW NUT 1/2-12--1/2-13	EA	2
14	16213-175L	JACKSCREW NUT M12-1.75--1/2--13	EA	2
15	16213-12L	JACKSCREW NUT 1/2-12--1/2--13	EA	2
16	16213-175	JACKSCREW NUT M12-1.75--1/2-13	EA	2
17	16214	NUT LEVELING 3/4-16	EA	3
18	16216	SCREW HEX HD	EA	1
19	98029A036	WASHER-FINISHED FLAT-CASE HARDENED STL	EA	1
20	3/4-16 51Z	NUT-HEX JAM-STL-ZINC-GRADE 2	EA	1
21	16364-3	SCREW 3/8-24 BRKT BALLNUT MOUNTING	EA	1
22	16739	JACKSCREW NUT	EA	1
23	14932	WASHER-LOWER BOLT	EA	2
24	15759	WASHER-1/4 HARD BLK OX 1/8 THK	EA	2
25	16355-3	SCREW M10.-1.0. BRKT. BALLNUT MOUNTING	EA	1
26	16365	SPACER CENTERING HOLE	EA	1
27	16212-175	COUPLING SOCKET HEAD	EA	2
28	1/4-20 56Z	NUT-NYLON LOCK-STL-ZINC	EA	2
29	16357-2	BRACKET BALLNUT FORK EXT SUPERMAX 16VS	EA	1
30	1/2-13X1 1/2 25B	SCREW-SHCS-STL-BO	EA	2
31	1/4-20X1 3/4 25B	SCREW-SHCS-STL-BO	EA	2
32	1/4-20X1 40B	SCREW-SOC SET-STL-BO-CUP	EA	4
33	1/4-20X3/4 25B	SCREW-SHCS-STL-BO	EA	2
34	1/4-20X3/8 40B	SCREW-SOC SET-STL-BO-CUP	EA	4
35	3/8-16 50B	NUT-HEX-STL-BO	EA	1
36	3/8 70P	WASHER-FLAT USS-STL-BO	EA	1
37	3/8 73B	WASHER-SPLIT LOCK-STL-BO	EA	2
38	16210-1	POSITIONER LOCATOR	EA	2
39	M6-1.0X25 25B	SCREW-SHCS-STL-BO	EA	2
40	M10 73B	WASHER-SPLIT LOCK-STL-BO	EA	1
41	16740	COUPLING SOCKET HEAD	EA	1
42	M6-1.0X75 25B	SCREW-SHCS-STL-BO	EA	4
43	3/8-24 x 2 ¼ 25B	SCREW-SHCS-STL-BO	EA	1

i25000-XX

8.2 Installation of the Ball Screw

1. Install the ball screw assembly as shown in Figure 67. Run the quill up and down over its full travel at each step to ensure that there is no binding. Adjust as necessary. You can mount a dial indicator on the top of the table, locating off the ballscrew. Move the knee up and down and tram in the ballscrew from front to back with the leveling nuts.

Note: Loosely install the ball screw at first, and then attach the fork with the quill near the top of its travel.

Caution!
Binding in the quill travel will impair system performance and may damage the ball screw assembly.

8.3 Installation of the Motor and Remaining Components

See figure 67 & 68

1. Install the motor mounting bracket to the top of the base plate.
2. Install the motor to this bracket. Install the belt between the pulleys and tension it by sliding the motor away from the head. Tighten the 4 screws that hold the motor down.
3. Install the limit switch brackets that hold the upper and lower quill limit switches in place. Manually move the ballscrew up until you reach a hard stop. Now move the ballscrew down 1 turn of the ballscrew and set the upper limit switch. The brackets are slotted to allow up and down adjustment. Move the ballscrew down to the bottom of its travel and once again turn the ballscrew 1 turn and set the lower limit switch. In other words, the limit switch should trip about 0.200" from the top and bottom of travel.
4. The limit switch cable plugs into the digital I/O port on the pendant for non-spindle control machines. For spindle control mills, the limit switch cable plugs into the digital I/O port on the spindle control electrics box
5. Temporarily install the Z electronic handwheel to the right side of the baseplate with 2 socket head cap screws. The Z electronic handwheel plugs into the Z-axis secondary feedback port on the cable breakout box.
6. Power up the control and verify the Z electronic handwheel works.
7. Verify the locations of the switches are set correctly to prevent a hard crash when the machine is moving at maximum rapid speed. Adjust switches as necessary.
8. Remove the Z electronic handwheel and install the covers and then re-mount the Z electronic handwheel.

See Figure 68-1 for an illustration of the ballscrew assembly.

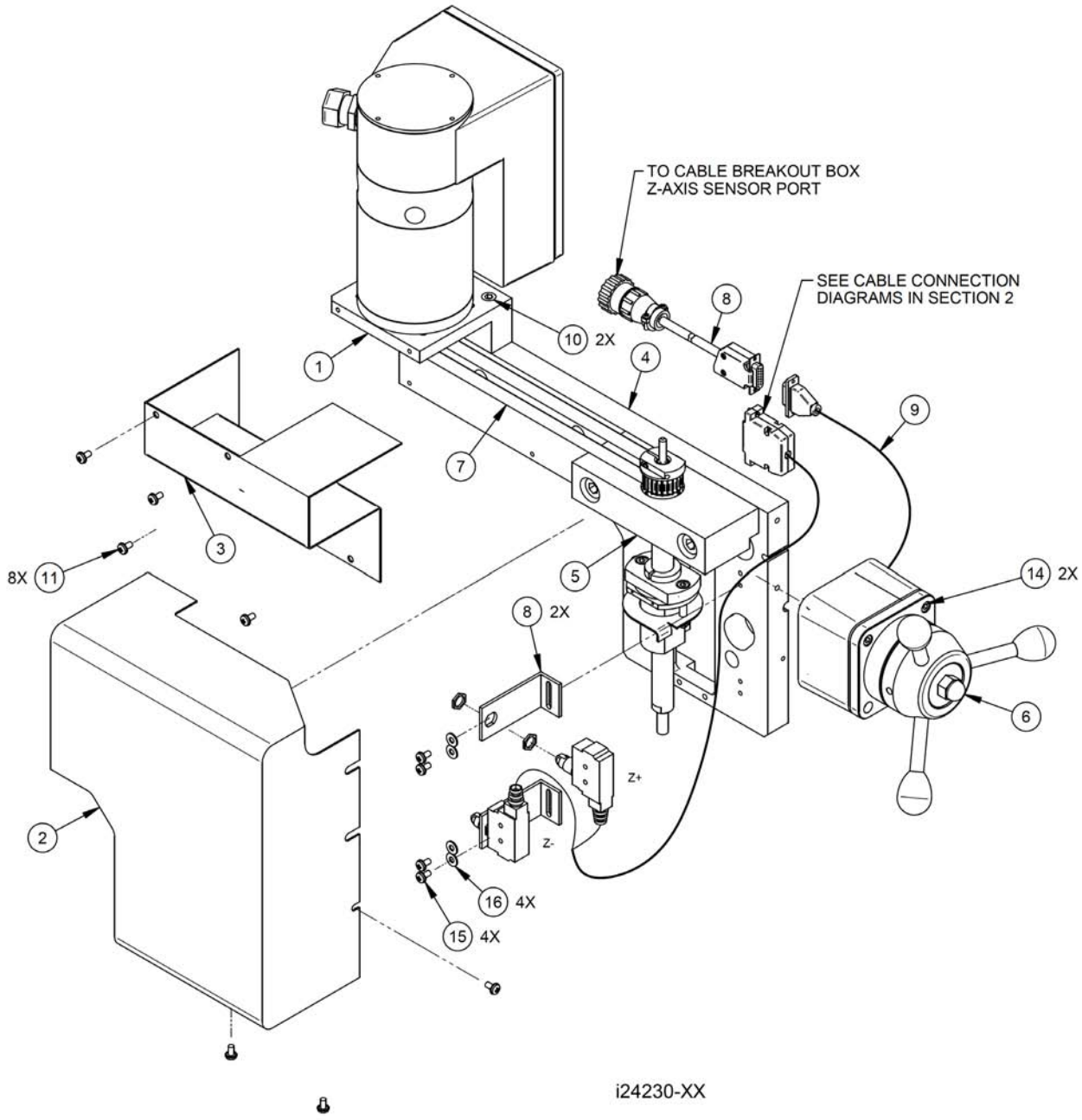


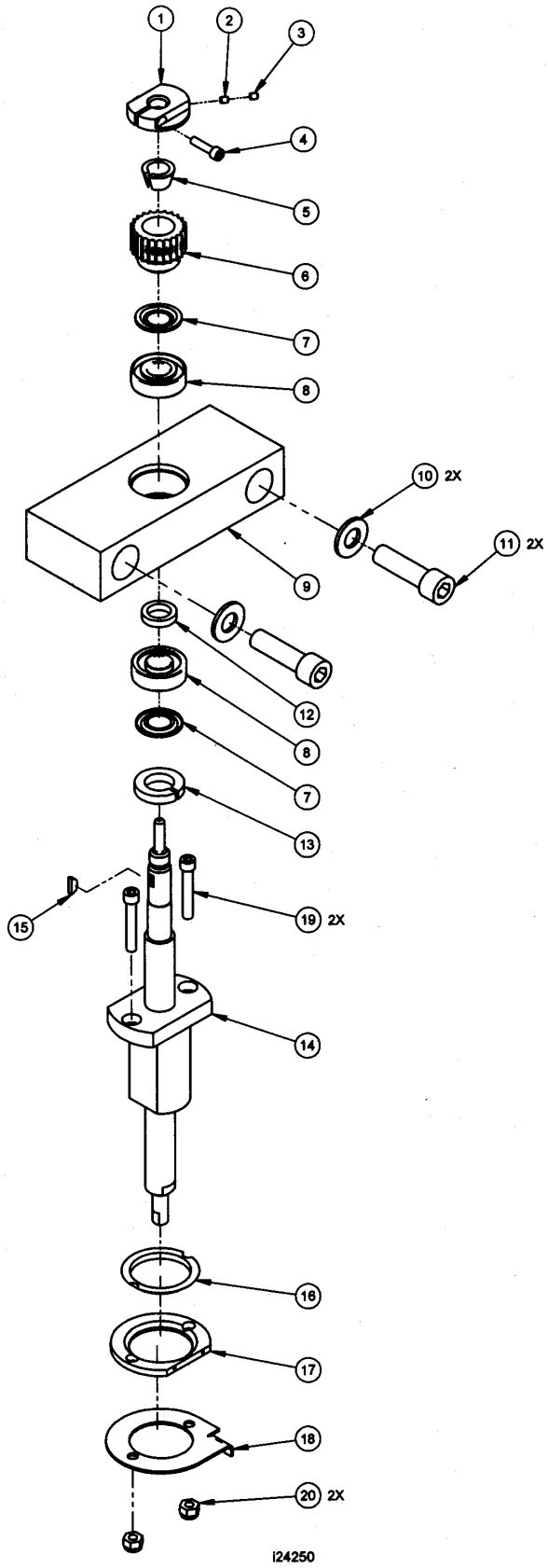
Figure 68
Z-Axis Motor, Electronic Handwheel & Covers Assembly

Parts List Z-Axis Motor, Electronic Handwheel & Covers Assembly

Item	P/N	Description	Use As	Qty
1	24217	BRACKET-SERVO MOTOR	EA	1
2	24221	COVER - FRONT	EA	1
3	24222	COVER LATERAL	EA	1
4	24240-1	BASE PLATE	EA	1
5	24250	BALLSCREW MODULE Z-AXIS	EA	1
6	21774	ELECTRONIC HANDWHEEL-DPMV Z-AXIS	EA	1
7	710-5M-15	BELT - TIMING	EA	1
8	22585	CABLE ASSY-ADAPTOR (DB15 TO AMP)	EA	1
9	24251	LIMIT SWITCH ASSY	EA	1
10	5/16-18X2 1/4 25B	SCREW-SHCS-STL-BO	EA	2
11	10-32X3/8 31B	SCREW-PH-PHIL-EXT SEMS-STL-BO	EA	8
12	24231	BRACKET-LIMIT SWITCH	EA	2
14	9688K321	PLUG-BLK	EA	2
15	10-32X1/2 25B	SCREW-SHCS-STL-BO	EA	4
16	10 70B	WASHER-FLAT USS-STL-BO	EA	4

i24230-1

Figure 68-1
Ball Screw Module
P/N 24250



Parts List Ball Screw Module

Item	P/N	Description	Use As	Qty
1	24223	NUT CLAMP-Z AXIS	EA	1
2	16263	PLUG BRASS	EA	1
3	10-32X1/4 41B	SCREW-SOC SET-STL-BO-FLAT	EA	1
4	10-32X3/4 25B	SCREW-SHCS-STL-BO	EA	1
5	16268	FERRULE	EA	1
6	24218	PULLEY-Z AXIS	EA	1
7	6002-AV	NILOS RING	EA	2
8	20372	BEARING-ANGULAR CONTACT 7202 BECBP	EA	2
9	24220	BEARING HOUSING-Z AXIS	EA	1
10	1/2 73B	WASHER-SPLIT LOCK-STL-BO	EA	2
11	1/2-13X2 3/4 25B	SCREW-SHCS-STL-BO	EA	2
12	16226	RING BEARING	EA	1
13	95571A837	WASHER- FLAT FELT 3/4 X 1/4 X 1/4	EA	1
14	16224	BALLSCREW Z-AXIS	EA	1
15	98481A090	KEY WOODRUFF #404-1/8 X 1/2	EA	1
16	14940	RING-ALIGNMENT	EA	1
17	14898	RING-ALIGNMENT	EA	1
18	24232	CAM-LIMIT SWITCH	EA	1
19	1/4-20X1 1/2 25B	SCREW-SHCS-STL-BO	EA	1
20	1/4-20 56Z	NUT-NYLON LOCK-STL-ZINC	EA	1

i24250

8.4 Lagun Z Axis Cutout

The ProtoTRAK SMX3 installation for the Lagun FTV2 requires the following material to be removed from the box that holds the Lagun nameplate.

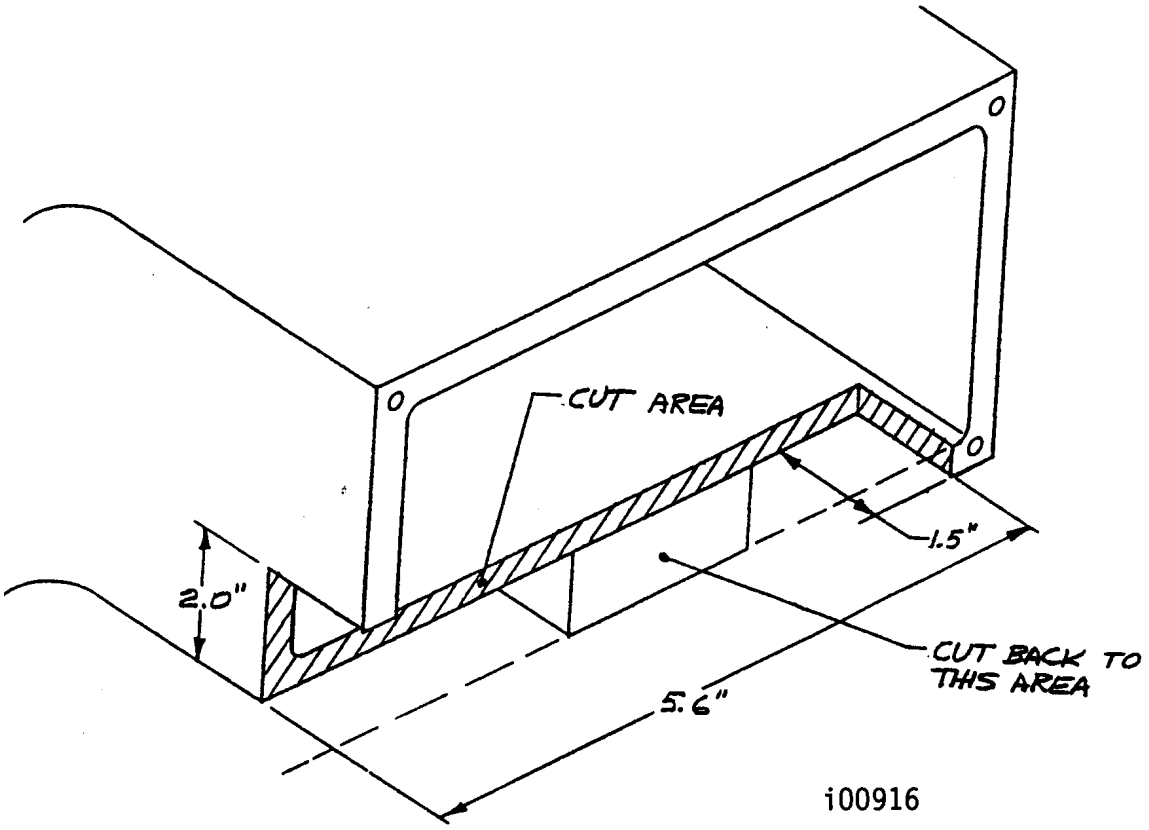


Figure 69

Unfortunately, there is not a really good way to do this. Your choices are:

- Have the head machined
- Use a hacksaw
- Drill a series of holes and use a wrench to break away pieces (our favorite)

The good news is that the resulting mess will be completely covered with the Z-axis assembly.

9.0 Introduction to Self-Service

The objective of this section of the manual is to allow the user of the ProtoTRAK Control to resolve the majority of potential service problems.

This manual assumes that the user is not experienced with CNC troubleshooting and repairs. Special tools are not required for the procedures described in the manual.

Please see Sections 3, 4 and 5 for in depth troubleshooting, diagnostics and procedure sections of the manual.

9.1 When You Have a Service Problem

SWI recommends that you consult this manual or our web site first. Often it will be possible for you to resolve the problem yourself or isolate the problem to a particular cause.

Your next step is to contact the SWI Customer Service Group for assistance.

9.1.1 Communication with the SWI Customer Service Group

- SWI Service Department Direct Line: (800) 367-3165
- Web Address – www.southwesternindustries.com

This phone line rings directly into the SWI Customer Service Group. If a Customer Service Representative (CSR) is not available within the first few of minutes, your call is transferred into our voice mail system.

Our voice mail is continuously monitored. If you have an emergency, indicate this in your message. Our Service Voice Mail box number is 555.

- SWI Service Department Direct Fax number (310) 886-8029
  Customer Service Group hours:
  Monday - Friday 7:00 AM to 4:30 PM Pacific Time.
  SWI observes a normal holiday schedule.

9.2 Warranty

TRAK products are warranted to the original purchaser to be free from defects in workmanship and materials for the following periods:

Product	Warranty Period
New TRAK	1 Year
Any Exchange Unit	90 Days*

*If installed within the original warranty period, the longer of the warranties applies.

The warranty period starts on the date of the invoice to the original purchaser from Southwestern Industries, inc. (SWI) or their authorized distributor.

If a unit under warranty fails, it will be repaired or exchanged at our option for a properly functioning unit in similar or better condition. Such repairs or exchanges will be made FOB

Factory/Los Angeles or the location of our nearest factory representative or authorized distributor.

9.2.1 Disclaimers of Warranties

- This warranty is expressly in lieu of any other warranties, express or implied, including any implied warranty of merchantability or fitness for a particular purpose, and of any other obligations or liability on the part of SWI (or any producing entity, if different).

- Warranty repairs/exchanges do not cover incidental costs such as installation, labor, freight, etc.

- SWI is not responsible for consequential damages from use or misuse of any of its products.

- TRAK products are precision mechanical/electromechanical measurement systems and must be given the reasonable care that these types of instruments require.

- Accidental damage, beyond the control of SWI, is not covered by the warranty. Thus, the warranty may not apply if an instrument has been abused, dropped, or hit.

- Improper installation by or at the direction of the customer in such a way that the product consequently fails, is considered to be beyond the control of the manufacturer and outside the scope of the warranty.

9.2.2 This Warranty Extends to Self-Service

SWI will not penalize a customer under our warranty terms for accidental damage to systems that results from attempting the procedures in this manual.

9.3 Replacements

9.3.1 Exchange Program

SWI keeps in stock the major subassemblies required to resolve service problems. With very few exceptions, the part needed to resolve any given service problem is on the shelf and ready to ship.

A little bit of troubleshooting on your part means that we can get the right part to you fast.

After replacing the failed unit with the replacement unit, simply put the failed unit in the same box that the replacement part came in and ship it back to us via UPS ground service.

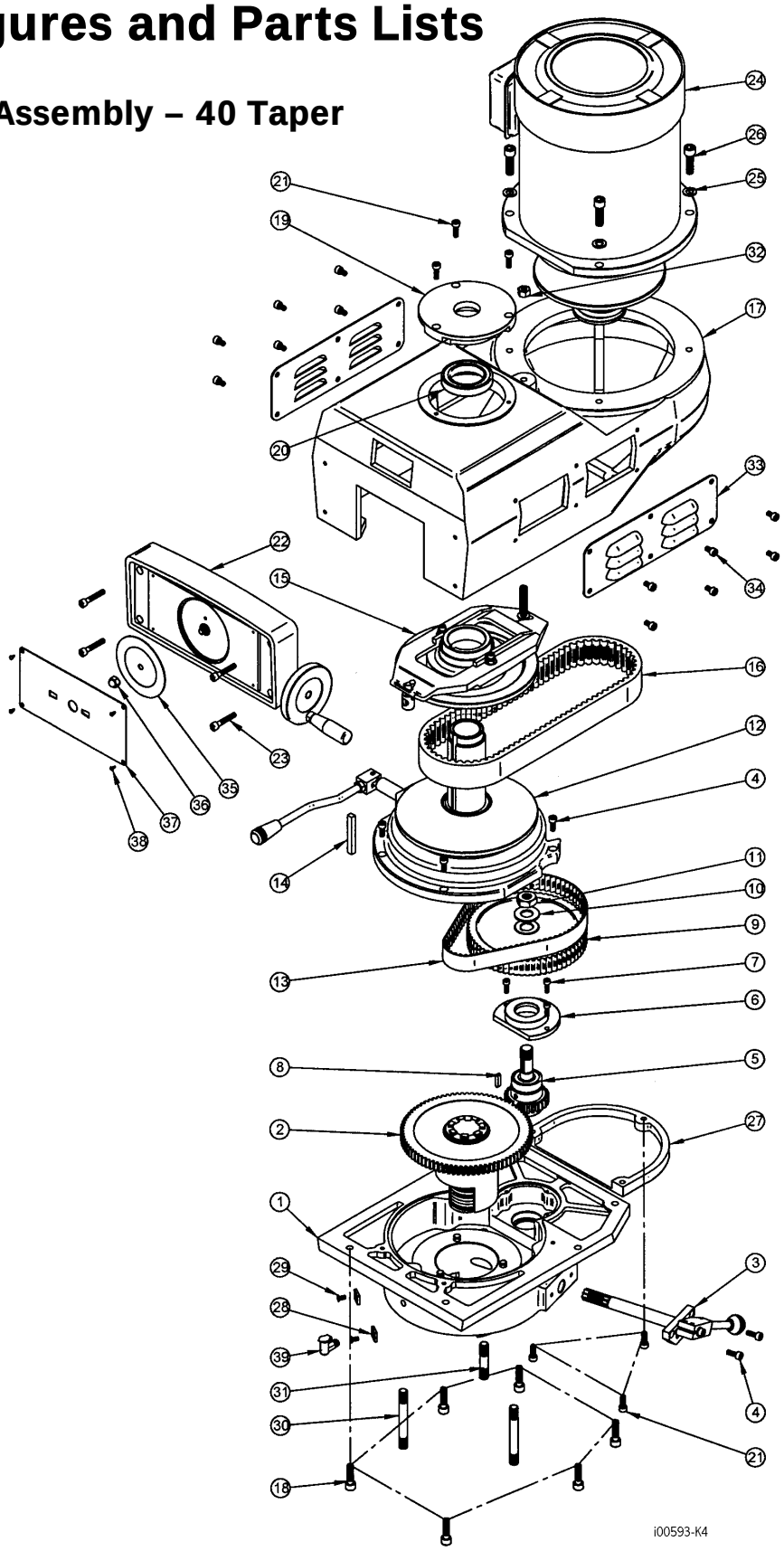
This unique Exchange program gives our customers access to re-built “like-new” subassemblies that have been brought up to current design revisions and go through the same QC procedures as our new products. These high-quality replacement units are available at a fraction of the price of a new subassembly.

9.3.2 Return Authorization (RA) Number

All shipments of replacement parts are accomplished through our Return Authorization (RA) system. At the same time the CSR is diagnosing the problem and ordering the part, they will issue an RA number that will allow us to efficiently process the return part.

10.0 Figures and Parts Lists

Figure 100
Top Housing Assembly – 40 Taper



Parts List - Top Housing Assembly – 24688-1

Item	P/N	DESCRIPTION	Qty
1	20697-1	GEAR HOUSING SUB-ASSY (4VK-A1)	1
2	20697-2	HI-LOW SHIFT CLUTCH SUB-ASSY (4VK-A2)	1
3	20697-3	HI-LOW SHIFT SUB-ASSY (4VK-A3)	1
4	FVS12	SOCKET CAP SCREW M6-P1.0x15L	2
5	20697-4	PULLY PINION SUB-ASSY (4VK-A4)	1
6	FVS64	BULL GEAR PINION BEARING CAP	1
7	FVS93	SCREW SOC HD M5-P0.8x15L	1
8	FVS117	KEY 5x520L	1
9	FVS62	TIMING BELT PULLEY	1
10	FVS126	WASHER Ø 5/8	1
11	FVS61	JAM NUT 5/8-11NC	1
12	20697-5	LOWER VARI-DISC DRIVE SUB-ASSY (4VK-A5)	1
13	FVS63	BELT 8YU-600L	1
14	FVS135	KEY 8x7x60L	1
15	20697-6	UPPER VARI-DISC DRIVE SUB-ASSY (4VK-A6) (Shown for reference only - See figure 106)	1
16	FVS4	BELT	1
17	FVS1	BELT HOUSING	1
18	FVS17	SOCKET CAP SCREW M6-P1.0x35L	1
19	FVS13	TOP BEARING CAP	1
20	FVS15	BALL BEARING (6909VV)	1
21	FVS129	SCREW- SOC HD CAP M6-P1.0x18L	1
22	20697-7	SPEED CHANGE HANDWHEEL SUB-ASSY (4VK-A7)	1
23	FVS10	SCREW- SOC HD CAP M8-P1.25x30L	1
24	20820	MOTOR ASSY-DPM5-5HP-GREEN (shown for reference only, not part of upper head housing assembly)	1
25	FVS130	WASHER- FLAT Ø 10.2	4
26	FVS111	SOC HD SCREW- 3/8-16NCx32L	4
27	FVS11	MOTOR PULLEY COVER	1
28	FVS104	COPPER CHIP(2REQ.)	2
29	FVS131	SCREW- FLAT HD PHILIP M5-P0.8x10L	1
30	FVS132	STUD Ø 7/16-92L	2
31	FVS133	STUD Ø 7/16-56L	1
32	FVS96	JAM NUT 3/8-16NC	1
33	FVS101	VENTILATOR(2REQ.)	2
34	FVS136	SCREW- SOC HD CAP M6-P1.0x10L	12
35	FVS16-1	VARI-SPEED DIAL	1
36	FVS95	HEX CAP NUT 5/16-18NC	1
37	FVS16-2	NAME PLATE	1
38	FVS19	DRIVE SCREW	1
39	OIL-1	FRU-K3-OIL CUP	1

i00593-K4

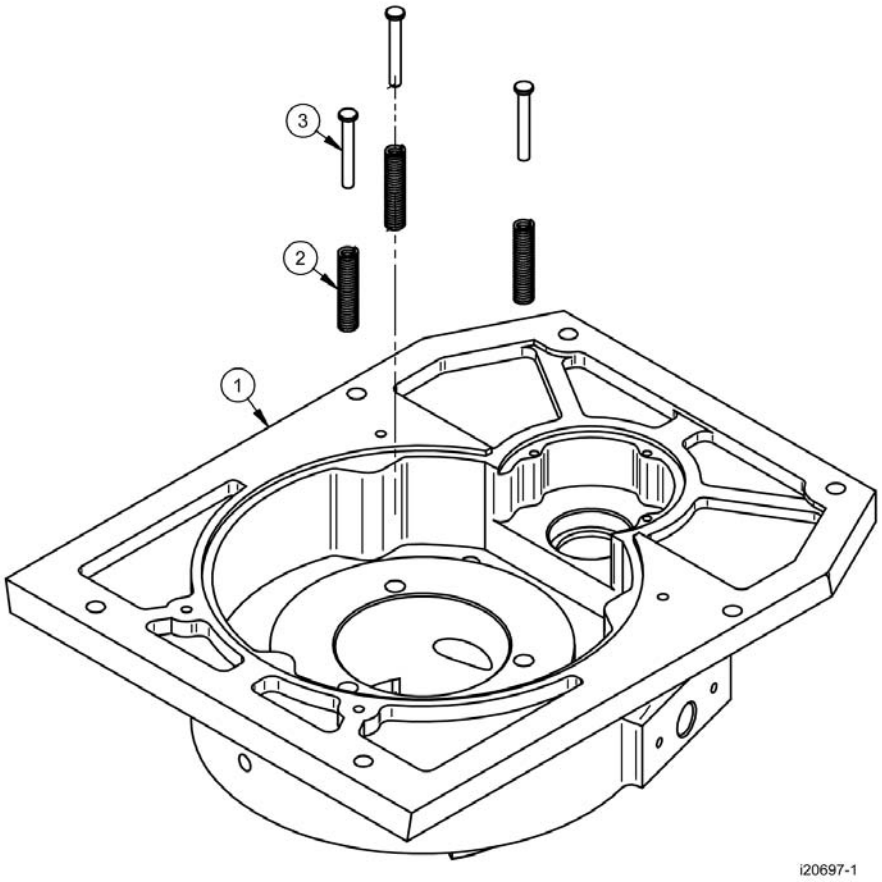
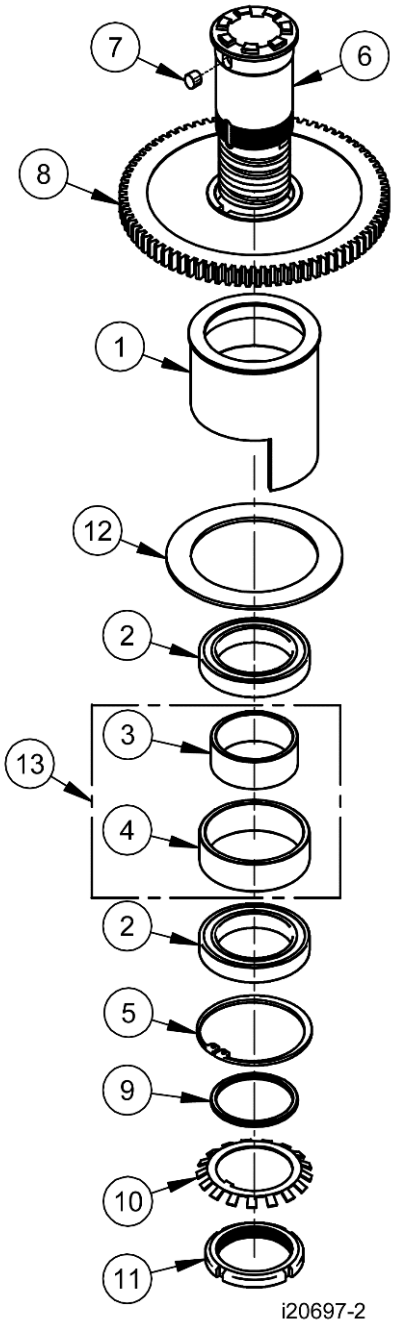


Figure 101
Gear Housing Sub-Assembly
P/N: 20697-1

Item	P/N	Description	Qty
1	FVS82	GEAR HOUSING	1
2	FV112	GUIDE SPRING	3
3	FV113	SPRING GUIDE PIN	3

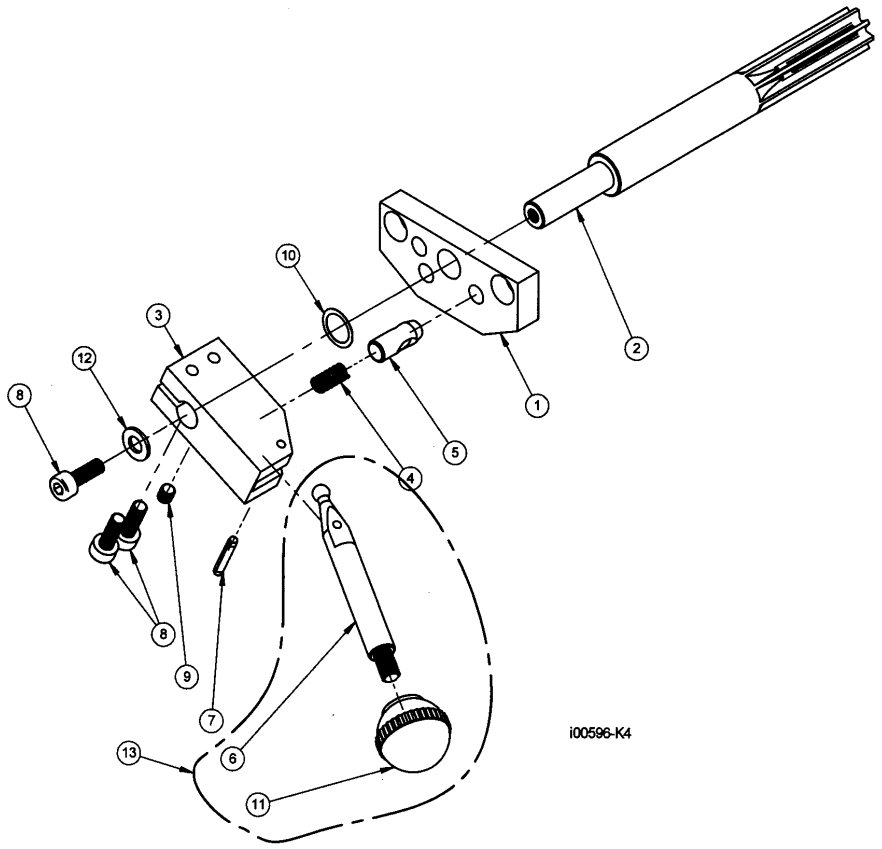
i00594-K4



Item	P/N	DESCRIPTION	Qty
1	FVS75	BEARING SLIDING HOUSING	1
2	23943	BALL BAEARING (2 REQ.) 6910ZZ	1 SET
3	FVS78	BEARING SPACER	1
4	FVS79	BEARING SPACER	1
5	FVS80	SNAP RING R-75	1
6	FVS73	SPLINED GEAR HUB	1
7	FVS72	KEY 8x7x10L	1
8	FVS74	SPINDLE BULL GEAR	1
9	FVS114	WASHER	1
10	FVS115	EXTERNAL TOOTH WASHER Ø 50	1
11	FVS81	LOCK WASHER Ø 50-18NC	1
12	FVS76	RING	1
13	20818	SPACER, BEARING	1

i00595-K4

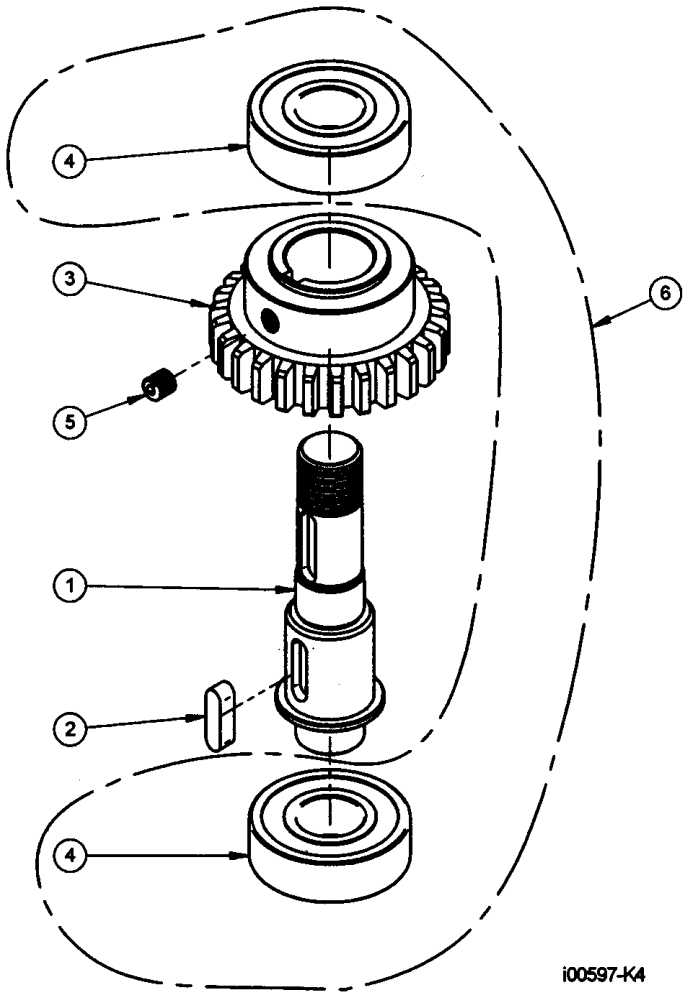
Figure 102
Hi-Low Slip Clutch
Sub-Assembly
P/N: 20697-2



Item	P/N	DESCRIPTION	Qty
1	FVS89	HI-LOW DETENT PLATE	1
2	FVS87	CLUTCH GEAR SHAFT	1
3	FVS92	HI-LOW PINION BLOCK	1
4	FVS91	SPRING	1
5	FVS90	HI-LOW DETENT PLUNGER	1
6	FVS94	HI-LOW SHAFT CRANK	1
7	FVS88	PIN Ø 319L	1
8	FVS93	SCREW SOC HD M5-P0.8x15L	3
9	FVS92-1	SET SCREW M5-P0.8x5L	1
10	FVS92-2	WASHER- FLAT Ø 11	1
11	FVS57	BAKELITE BALL HANDLE	1
12	FVS116	WASHER- FLAT Ø 6	1
13	24083	SHAFT HI/LOW SHAFT ASSY	1

i00596-K4

Figure 103
Hi-Low Shift Sub-Assembly
P/N: 20697-3



Item	P/N	DESCRIPTION	Qty
1	FVS67	BULL GEAR PINION COUNTER SHAFT	1
2	FVS69	KEY 5518L	1
3	FVS66	BULL GEAR PINION	1
4	AK118	BALL BEARING (2 REQ.) 6203ZZ	2
5	FVS3	SOCKET SET SCREW M6-P1.0x6L	1
6	23954	BEARING SET (2) -BEARINGS 6203ZZ	1

i00597-K4

Figure 104
Pulley Pinion Sub-Assembly
P/N: 20697-4

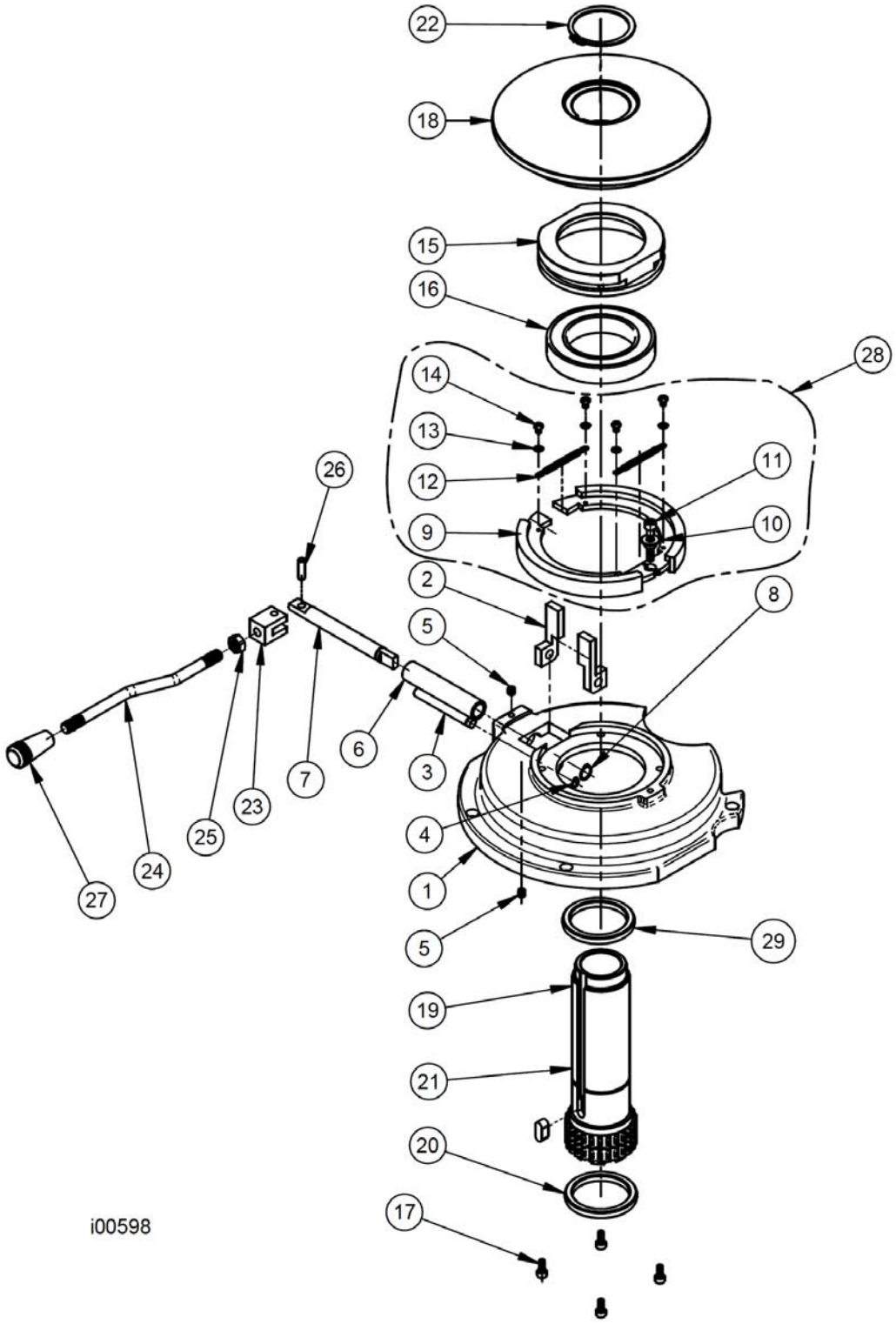


Figure 105
Lower Vari-Disc Sub-Assembly
P/N: 20697-5 (assembly not available, order parts separately)

Parts List - Lower Vari-Disc Sub-Assembly

Item	P/N	DESCRIPTION	Qty
1	FVS50	BELT HOUSING BASE	1
2	FVS59	BRAKE BLOCK	2
3	FVS58	TURNING BLOCK SHAFT	1
4	FVS103	RETAINING RING Ø 7	1
5	FVS51	SET SCREW M6-P1.06L	2
6	FVS53	BRAKE LOCK BUSHING	1
7	FVS52	BRAKE LOCK SHAFT	1
8	FSV119	RETAINING RING Ø 11	1
9	FVS47	BRAKE SHOE	2
10	FVS48	BRAKE SHOE PIVOT SLEEVE	1
11	FVS17	SOCKET CAP SCREW M6-P1.0x35L	1
12	FVS49	BRAKE SPRING	2
13	FVS122	WASHER Ø 6	4
14	FVS120	SCREW- PHILLIP PAN HD 3/16-24NC6L	4
15	FVS46	BRAKE BEARING CAP	1
16	AK048	BALL BEARING 6012ZZ	1
17	FVS14	SOCKET CAP SCREW M 5-PO.8x12L	4
18	FVS45	STATIONARY DRIVEN VARIDISC	1
19	FVS70	SPINDLE PULLEY ASSY	1
20	FVS100	SPINDLE PULLEY SPACER	1
21	FVS71	KEY 8x8x20L	1
22	FVS97	SNAP RING Ø 50	1
23	FVS52-1	BRAKE LOCK SHAFT SWIVEL	1
24	FVS56	BRAKE LOCK HANDLE	1
25	FVS54	HANDLE FIX BLOCK 3/8-16NC	1
26	FVS55	SPRING PIN Ø 6x20L	1
27	FVS57-1	BAKELITE BALL HANDLE 3/8-16NC	1
28	24055	BRAKE SHOE ASSY	1
29	FVS98	CLUTCH WASHER	1

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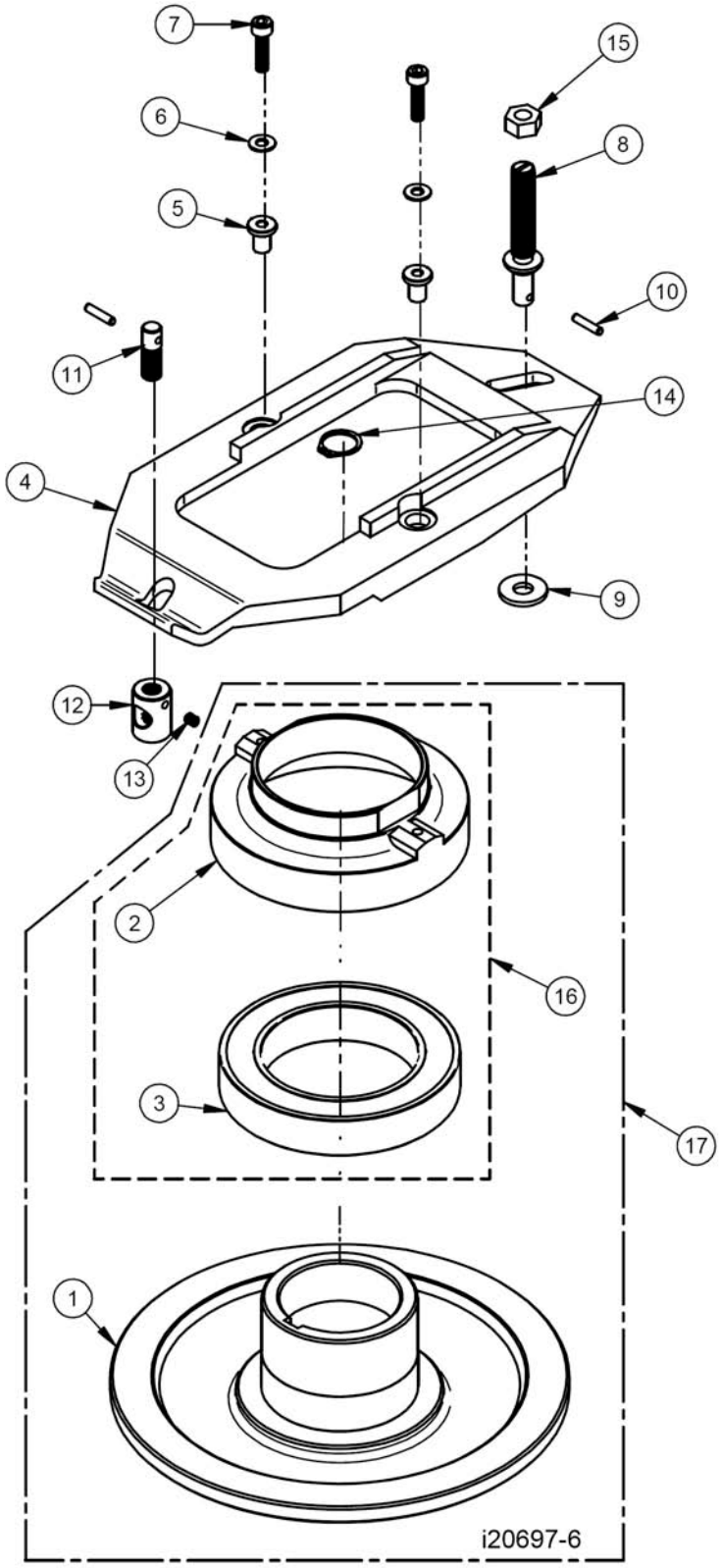
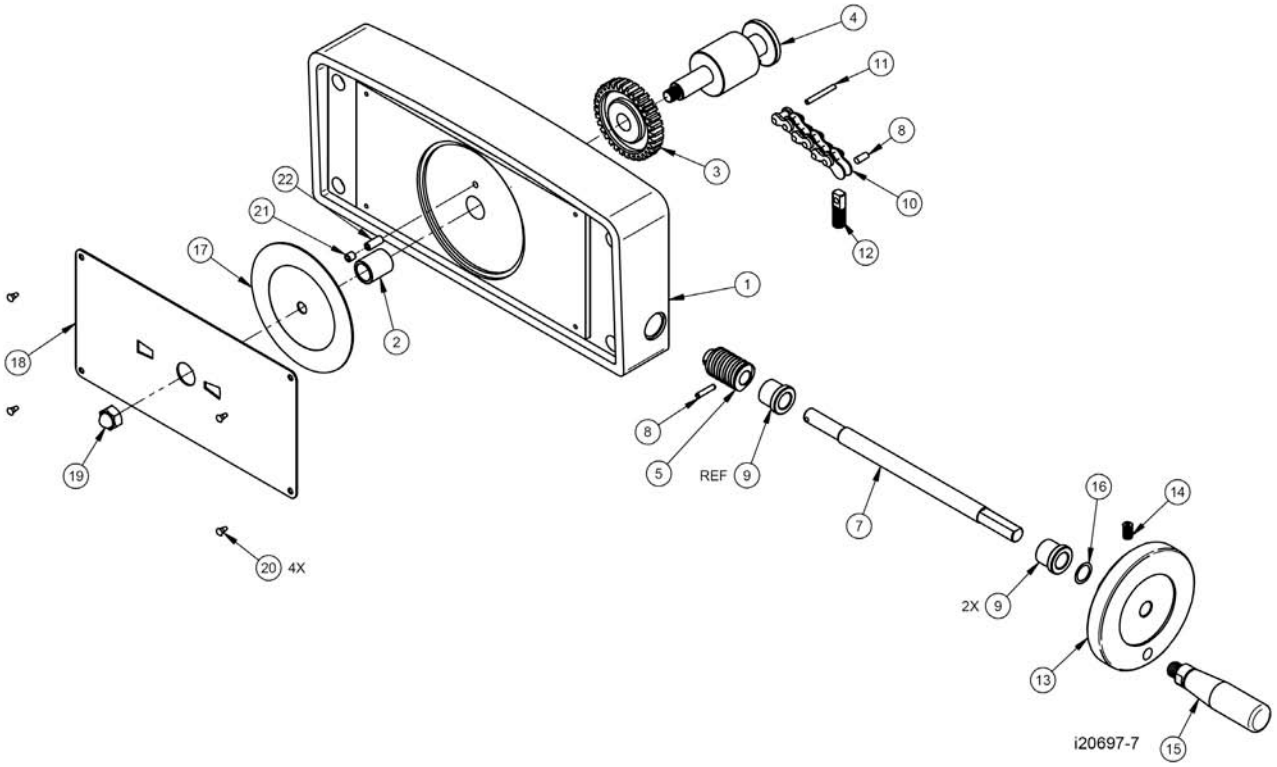


Figure 106
Upper Vari-Disc Sub-Assembly
P/N: 20697-6

Parts List - Upper Vari-Disc Sub-Assembly

Item	P/N	DESCRIPTION	Qty
1	FVS44	ADJUSTABLE-DRIVEN VARIDISC	1
2	FVS42	SPINDLE PULLEY BEARING HOUSING	1
3	FVS43	BALL BEARING 6013ZZ	1
4	FVS36	SPEED CHANGE PLATE	1
5	FVS38	PIVOT SLEEVE Ø 5	2
6	FVS37	WASHER M5-P0.8x20L	2
7	FVS3123	SOCKET CAP SCREW	2
8	FVS39	SPEED CHANGE PLATE PIVOT STUD	1
9	FVS41	WASHER Ø 8.2	1
10	FVS40	ROLL PIN Ø3x15L	2
11	FVS35	CHAIN END STUD	1
12	FVS34	ADJUSTMENT NUT	1
13	FVS33	CHAIN FRONT SCREW M4-P0.7x5L	1
14	FVS97	SNAP RING Ø 50	1
15	FVS96	JAM NUT 3/8-16NC	1
16	24599	BEARING HOUSING ASSY-K4	1
17	24603	VARIDISC ASSY-ADJUSTABLE	1

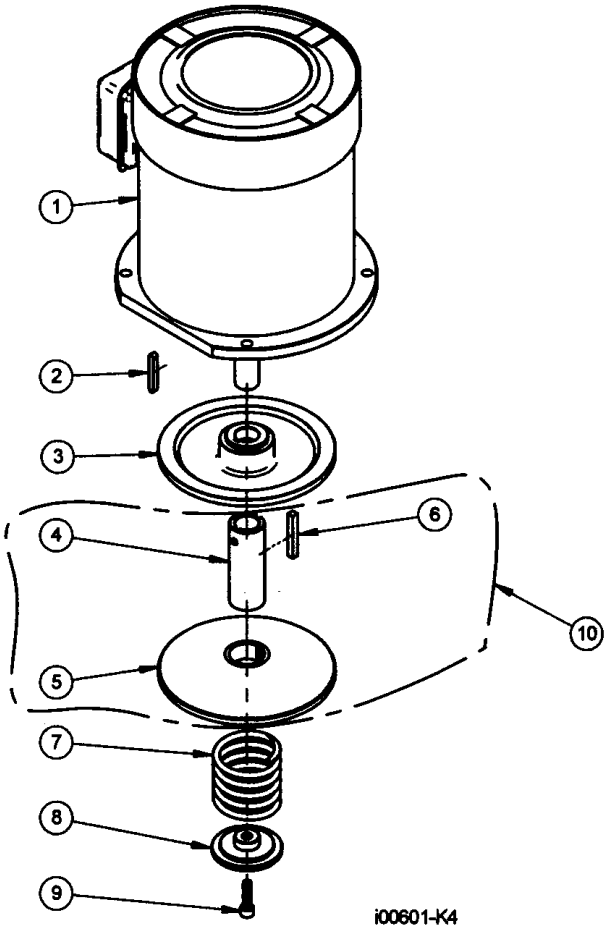
i20697-6



Item	P/N	Title	Qty
1	FVS16	SPEED CHANGE HOUSING	1
2	FVS20	BEARING SELF LUBRICATING	1
3	FVS22	SPEED CHANGER GEAR	1
4	FVS31	SPEED CHANGE CHAIN DRUM	1
5	FVS21	WORM	1
7	FVS25	SPEED CHANGE SHAFT	1
8	FVS40	ROLL PIN Ø3x15L	2
9	FVS24	COPPER BUSHING	2
10	FVS32	CHAIN #3109.525	1
11	FVS31-1	DOWEL PIN Ø3x25L	1
12	FVS30	SPEED CHANGE STUD	1
13	FVS27	SPEED CHANGE HANDWHEEL	1
14	FVS18	FULL DOG SOCKET SET SCREW M6-P1.0x10L	1
15	FVS28	HANDLE 3/8-16NC	1
16	VS24-1	WASHER-WAVE	1

i20697-7

Figure 107
Speed Change Handwheel Sub-Assembly,
P/N: 20697-7



Item	P/N	Title	Qty	Notes
1	FVS110	MOTOR 5 HP	1	only available as 20820
2	FVS3-1	KEY 6x6x45L	1	only available as 20820
3	FVS2	STATIONARY MOTOR VARIDISC	1	only available as 20820
4	FVS6	BUSHING	1	available as 24054 or 20820
5	FVS5	ADJUSTABLE MOTOR VARIDISC	1	available as 24054 or 20820
6	FVS6-1	KEY 7x7x50L	1	available as 24054 or 20820
7	FVS8	SPRING FOR VARIDISC MOTOR SHAFT	1	only available as 20820
8	FVS9	ADJUSTABLE VARIDISC SPRING COLLAR	1	only available as 20820
9	FVS10	SCREW- SOC HD CAP M8-P1.25x30L	1	only available as 20820
10	24054	VARIDISC ASSY	1	

i00601-K4

Figure 108
Spindle Motor Sub-Assembly
P/N: 20820

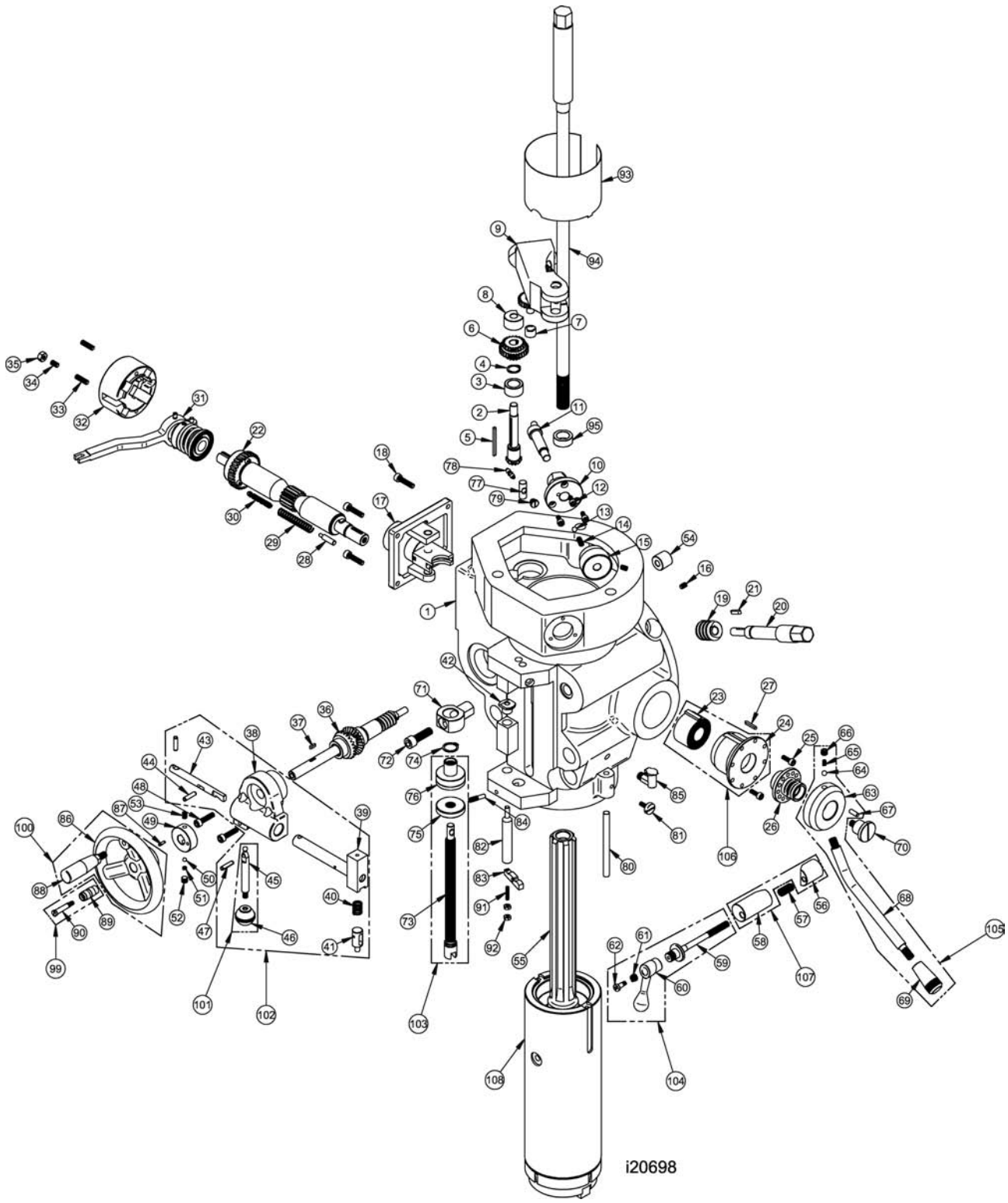


Figure 109
Bottom Housing Assembly

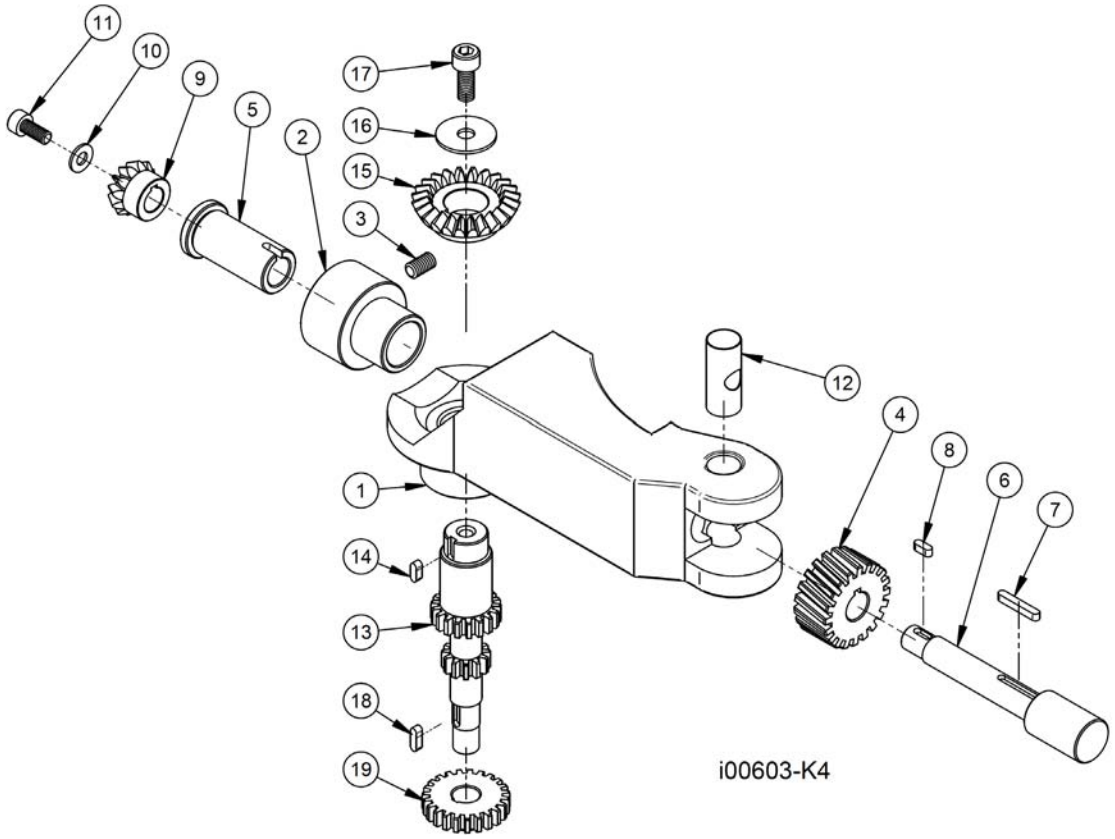
Parts List - Bottom Housing Assembly

Item	P/N	Title	Qty
1	FB192	QUILL HOUSING	1
2	FB31	CLUSTER GEAR SHAFT	1
3	FB33	BEVEL GEAR BEARING	1
4	FB94	SNAP RING 95 DOWEL PIN Ø 14	1
5	FB29	CLUSTER GEAR KEY 3x3x45L	1
6	FB28	CLUSTER GEARS ASSEMBLY	1
7	FB41	NEEDLE BEARING KO-BA66Z	1
8	FB27	CLUSTER GEAR SHAFT UPPER BEARING	1
9	20698-1	WORM GEAR CRADLE SUB-ASSY (4VK-H1)	1
10	FB19	SHIFT SLEEVE	1
11	FB18	WORM GEAR CRADLE THROW-OUT	1
12	FB20	CAP SCREW M5-P0.8x12L	1
13	FB24	STEEL BALL	1
14	FB25-A	SPRING	1
15	FB23	SHIFT CRANK	1
16	FB68	SET SCREW M6-P1.0x8L	1
17	20698-2	QUILL FEED SELECTOR SUB ASSY (4VK-H2)	1
18	FB67	CAP SCREW M6-P1.0x18L	4
19	FB186	WORM GEAR	1
20	FB189	ADJ WORM SHAFT	1
21	FB187	KEY 4x4x18L	1
22	20698-3	SUB-ASSY-QUILL PINION SHAFT-40 TAPER	1
23	FB178	CLOCK SPRING (CLOCK SPRING ASSY.)	1
24	FB177	SPRING COVER	1
26	FB176	PINION SHAFT HUB SLEEVE	1
27	FB171	KEY 3x3x20L	1
28	FB89	OVERLOAD CLUTCH LEVER SPRING PLUNGER	1
29	FB88	COMPRESSION SPRING	1
30	FB88-1	INTERNAL COMPRESSION SPRING	1
31	20698-4	OVERLOAD CLUTCH TRIP SUB-ASSY (4VK-H4)	1
32	FB99	CLUTCH ARM COVER	1
33	FB73	CAP SCREW M5-P0.8x40L	2
35	FB101	CHEM BLACKED LOCKNUT M6-P1.0	1
36	20698-5	FEED REVERSE CLUTCH SUB-ASSY (4VK-H5)	1
37	FB109	KEY 3x3x20L	1
38	FB106	FEED TRIP BRACKET	0
39	FB118	CAM ROD SLEEVE ASSY.	1
40	FB120	COMPRESSION SPRING	1
41	FB121	TRIP PLUNGER	1
42	FB123	TRIP PLUNGER BUSHING	1
43	FB103	CAM ROD	1
44	FB117	ROLL PIN Ø 3x15L	1
45	FB104	TRIP HANDLE	1
46	FB105	BLACK PLASTIC BALL	1
47	FB119-1	ROLL PIN Ø 3x20L	1
48	FB107	CAP SCREW M6-P1.0x25L	2
49	FB113	HAND WHEEL CLUTCH	1

51	FB115	COMPRESSION SPRING	1
53	FB108	SET SCREW M6-P1.0x8L	1
54	FB42	BUSHING	1
55	20836-1	SPINDLE ASSY-40 TAPER	1
56	FB148	QUILL LOCK SLEEVE TAPPED	1
57	FB148-1A	COMPRESSION SPRING	1
58	FB153	QUILL LOCK SLEEVE	1
59	FB152	QUILL LOCK BOLT	1
60	FB149	LOCK HANDLE	1
61	FB149-1	CONICAL COMPRESSIONAL SPRING	1
62	FB149-2	SCREW- PHILLIP HD	1
63	FB175	RACK FEED HANDLE HUB	1
64	FB114	STEEL BALL	2
65	FB175-2A	COMPRESSION SPRING	1
66	FB116	HANDWHEEL CLUTCH SPRING SCREW M8-P1.25x6L	2
67	FB175-3	DOWEL PIN	1
68	FB190	PINION SHAFT HUB HANDLE	1
69	FB191	PLASTIC BALL HANDLES	1
70	FB169	SOC HEAD SCREW M5-P0.8x15L	4
71	FB163	QUILL STOP KNOB	1
72	FB200	SCREW- SOC HD 3/8-24NF x 1 1/4	1
73	FB164	QUILL STOP MICRO-SCREW	1
74	FB160	SNAP RING Ø16	1
75	FB161	QUILL MICRO-STOP NUT	1
76	FB162	MICROMETER NUT	1
77	FB184	FEED REVERSE TRIP PLUNGER	1
78	FB183	REVERSE TRIP BALL LEVER	1
79	FB185	REVERSE TRIP BALL LEVER SCREW	1
80	FB202	INDICATOR ROD	1
81	FB201	INDICATOR ROD SCREW	1
82	FB124	FEED TRIP PLUNGER	1
83	FB145	FEED TRIP LEVER	1
84	FB144	SOCKET SET SCREW	1
85	OIL-1	FRU-K3-OIL CUP	1
86	FB125	HANDWHEEL	1
87	FB125-1	HANDWHEEL SPRING PIN - Ø 3x3x10L	1
88	FB125-2	HANDWHEEL HANDLE	1
89	FB111	REVERSE KNOB	1
90	FB100	SOCKET SET SCREW M6-P1.0x20L	2
91	FB124-1	FEED TRIP PLUNGER SOC SET SCREW M4-P0.7x20L	1
92	FB124-2	FEED TRIP PLUNGER NUT M4-P0.7x20L	2
93	FB128	QUILL SKIRT	1
94	FVS109	DRAWBAR 5/8-11NC	1
95	FVS109-1	SPACER	1
96	25041	SCALE-HEAD ROTATION-NT40	1
97	25043	POINTER SCALE	1
98	25044	DRIVE SCREW-SCALE	4
99	20834	FEED REVERSE KNOB ASSY	1
100	20835	HANDWHEEL ASSY	1

101	24099	TRIP HANDLE ASS'Y (INCLUDES PLASTIC BALL)	1
102	20833	FRU-K4-FEED TRIP ASSY	1
103	20847	QUILL MICRO NUT & SCREW ASSY	1
104	20846	QUILL LOCK HANDLE ASSY	1
105	20850	FEED HANDLE ASSY	1
106	24095	CLOCK SPRING ASSEMBLY (SPRING & COVER)	1
107	20844	QUILL LOCK SLEVE ASSY	1
108	FB142	QUILL	1
109	A071	T BOLT ASSY (includes A070, A071, A069) (not shown on drawing)	4

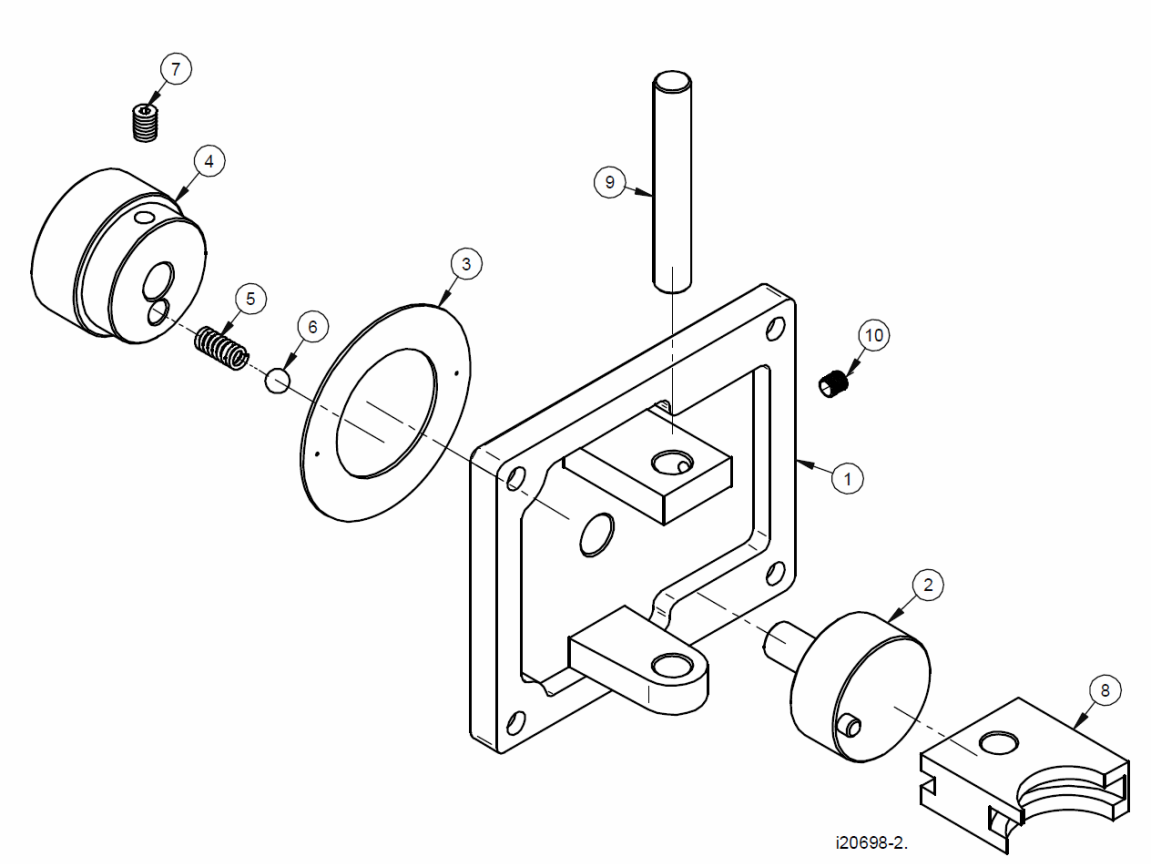
i20698



Item	P/N	Title	Qty
1	FB17	WORM GEAR CRADLE	1
2	FB5	WORM CRADLE BUSHING	1
3	FB6	SETSCREW M6-PP1.0x10L	1
4	FB8	FEED DRIVEWORM GEAR	1
5	FB4	FEED WORM GEAR SHAFT SLEEVE	1
6	FB9	FEED DRIVE WORM GEAR SHAFT	1
7	FB11	KEY 3x3x20L	1
8	FB10	WORM SHAFT KEY 3x3x8L	1
9	FB3	FEED BEVEL PINION	1
10	FB2	BEVEL PINION WASHER Ø 5	1
11	FB1	SOC.HD.SCREW M5-P0.8x10L	1
12	FB16	FEED ENGAGE PIN	1
13	FB36	FEED DRIVING GEAR	1
14	FB36-1	KEY 3x3x8L	1
15	FB15	FEED REVERSE BEVEL GEAR	1
16	FB13	WASHER Ø 6 Ø 22	1
17	FB14	SOC HD SCREW M6-P1.0x15L	1
18	FB37	KEY 3x3x10L	1
19	FB40	FEED DRIVE GEAR	1

i00603-K4

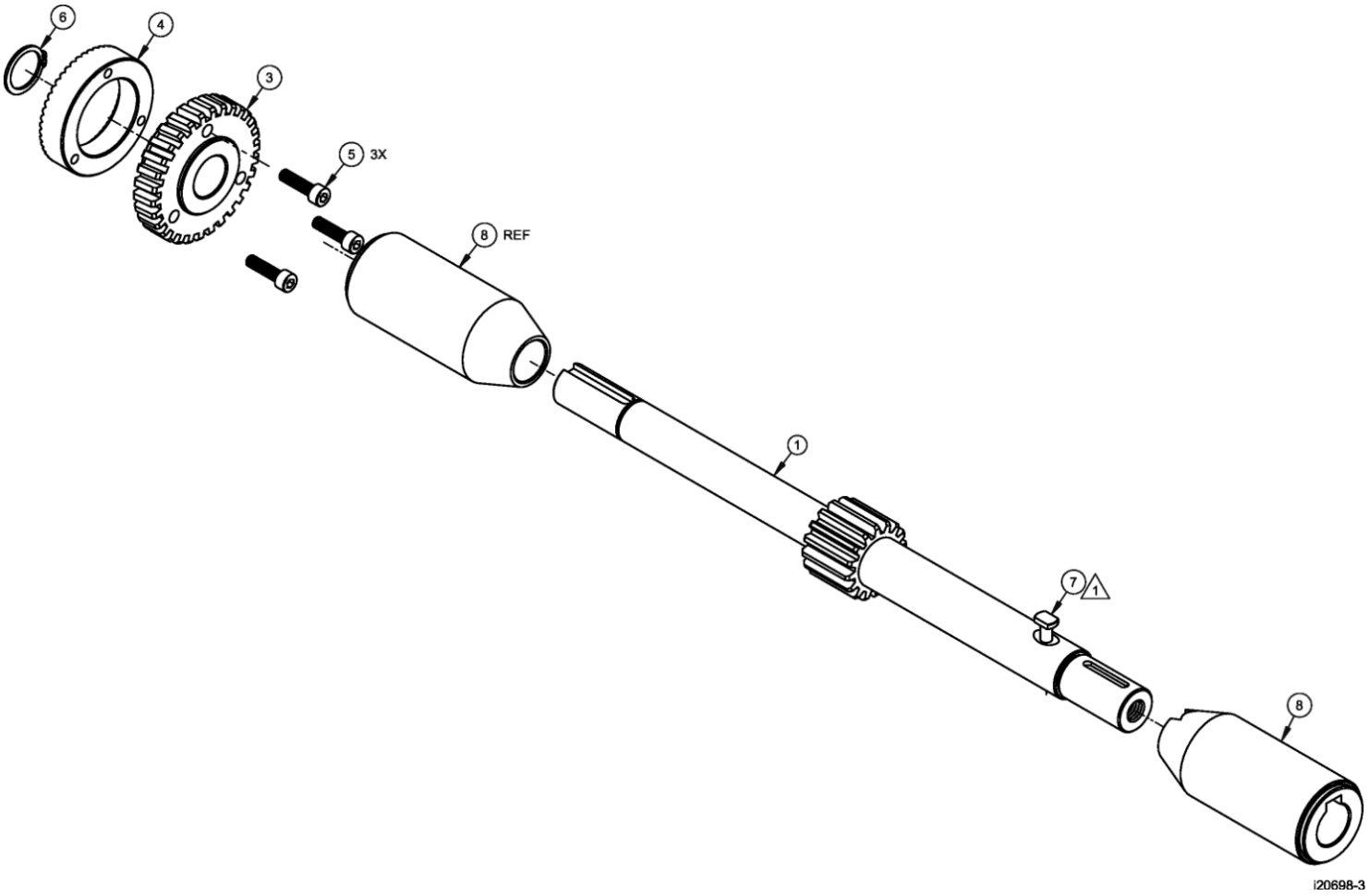
Figure 110
Worm Gear Cradle Sub-Assembly
P/N: 20698-1



Item	P/N	DESCRIPTION	Qty
1	FB66	CLUSTER GEAR COVER	1
2	FB64	CLUSTER GEAR SHIFT CRANK	1
3	FB69-1	DIAL	1
4	FB69	SHIFT KNOB	1
5	FB71	SPRING	1
6	FB70	STEEL BALL	1
7	FB68	SET SCREW M6-P1.0x8L	1
8	FB63	FEED GEAR SHIFT FORK	1
9	FB60	FEED SHIFT ROD	1
10	FB61	KP.SET SCREW M5-P0.8x6L	1

i00604-K4

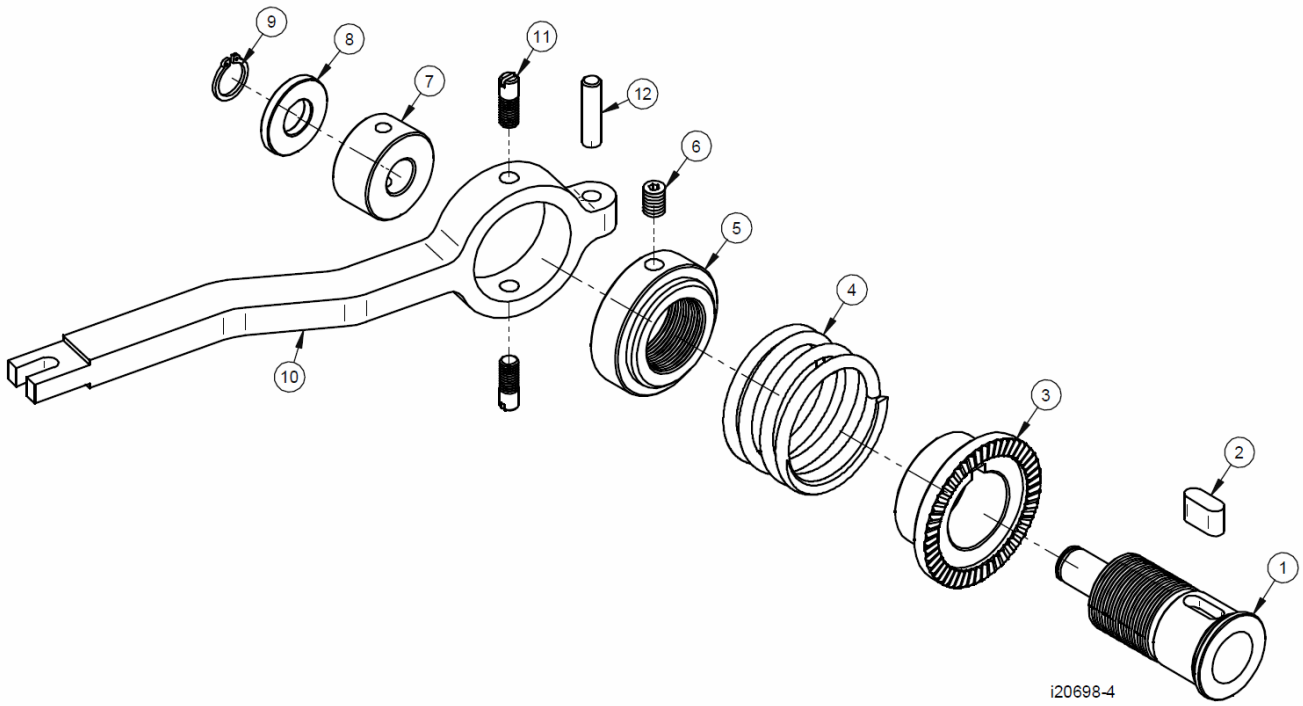
Figure 111
Quill Feed Selector Sub-Assembly
P/N: 20698-2



Item	P/N	Title	UseAs	Qty
1	FB166	QUILL PINION SHAFT	EA	1
3	K-B92	OVERLOAD CLUTCH WORM GEAR	EA	1
4	K-B93	OVERLOAD CLUTCH RING	EA	1
5	K-B92-1	SCREW SOC HD CAP M4-P0.7x15L	EA	3
6	K-B94	SNAP RING 95 DOWEL PIN Ø 14	EA	1
7	K-B168	SCREW PIN	EA	(1)
8	25707	BUSHING KIT-PINION SHAFT-40 TAPER	EA	1

i20698-3

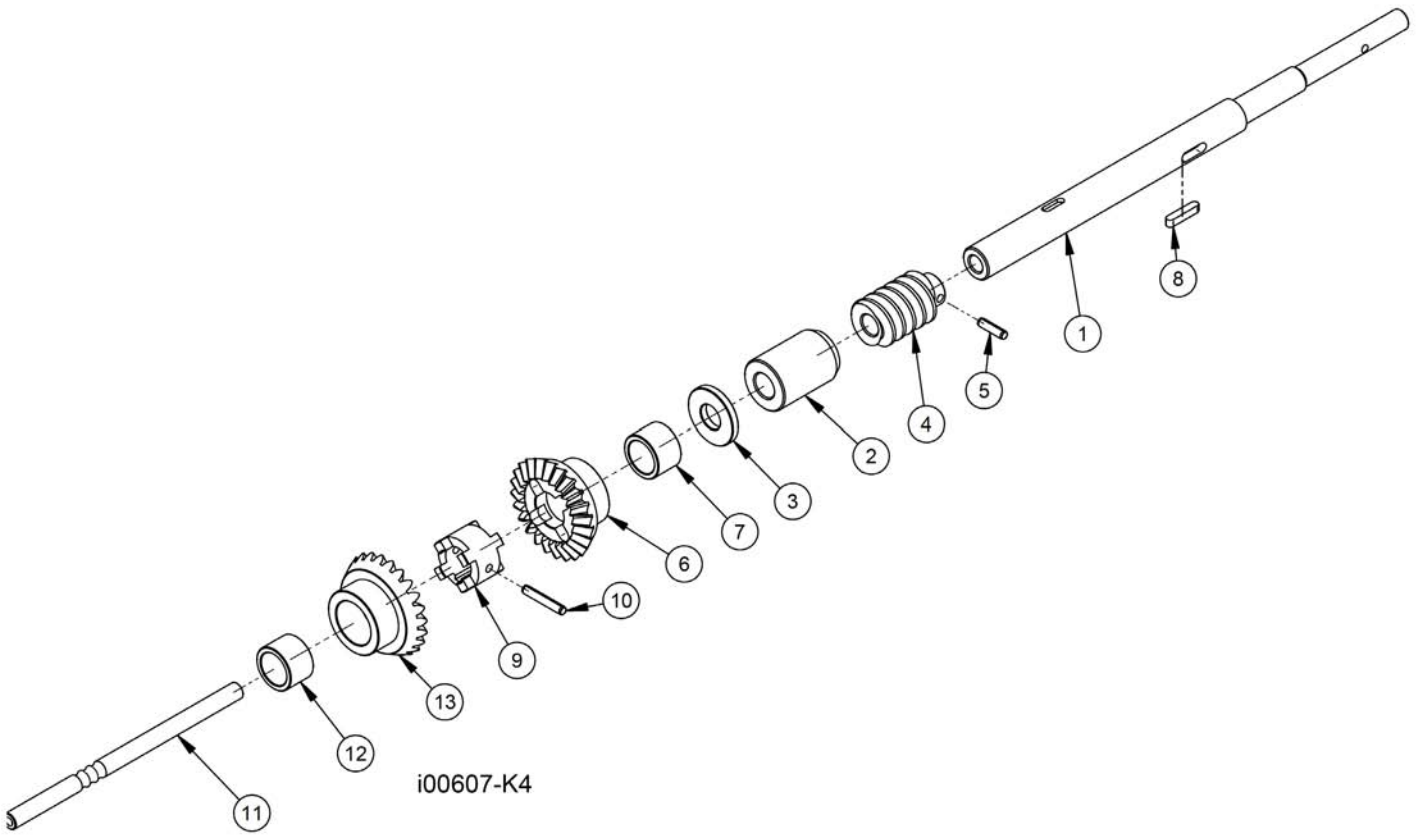
Figure 112
Quill Pinion Shaft Sub-Assembly
P/N: 20698-3



Item	P/N	Title	Qty
1	FB81	OVERLOAD CLUTCH SLEEVE	1
2	FB81-1	KEY 5x8x13L	1
3	FB80	OVERLOAD CLUTCH	1
4	FB79	SAFETY CLUTCH SPRING	1
5	FB78	OVERLOAD CLUTCH LOCKNUT	1
6	FB76	SOCKET SET SCREW M6-P1.0x8L	1
7	FB75	CLUTCH RING	1
8	FB97	OVERLOAD CLUTCH WASHER	1
9	FB98	SNAP RING Ø 10	1
10	FB96	OVERLOAD CLUTCH TRIP LEVER	1
11	FB74	CLUTCH RING PIN (2REQ.)	2
12	FB77	BRASS PLUG	1

i00606-K4

Figure 113
Overload Clutch Trip Sub-Assembly
P/N: 20698-4



Item	P/N	Title	Qty
1	FB57	FEED WORM SHAFT	1
2	FB44	FEED WORM SHAFT BUSHING	1
3	FB47	FEED WORM SHAFT THRUST WASHER	1
4	FB43	WORM	1
5	FB59	PIN Ø 3x12L	1
6	FB49	FEED REVERSE BEVEL GEAR	1
7	FB48	BUSHING	1
8	FB62	KEY 3x3x15L	1
9	FB50	FEED REVERSE CLUTCH	1
10	FB50-1	PIN Ø 3x19L	1
11	FB55	REVERSE CLUTCH ROD	1
12	FB52	BUSHING	1
13	FB51	FEED REVERSE BEVEL GEAR	1

i00607-K4

Figure 114
Feed Reverse Clutch Sub-Assembly
P/N: 20698-5

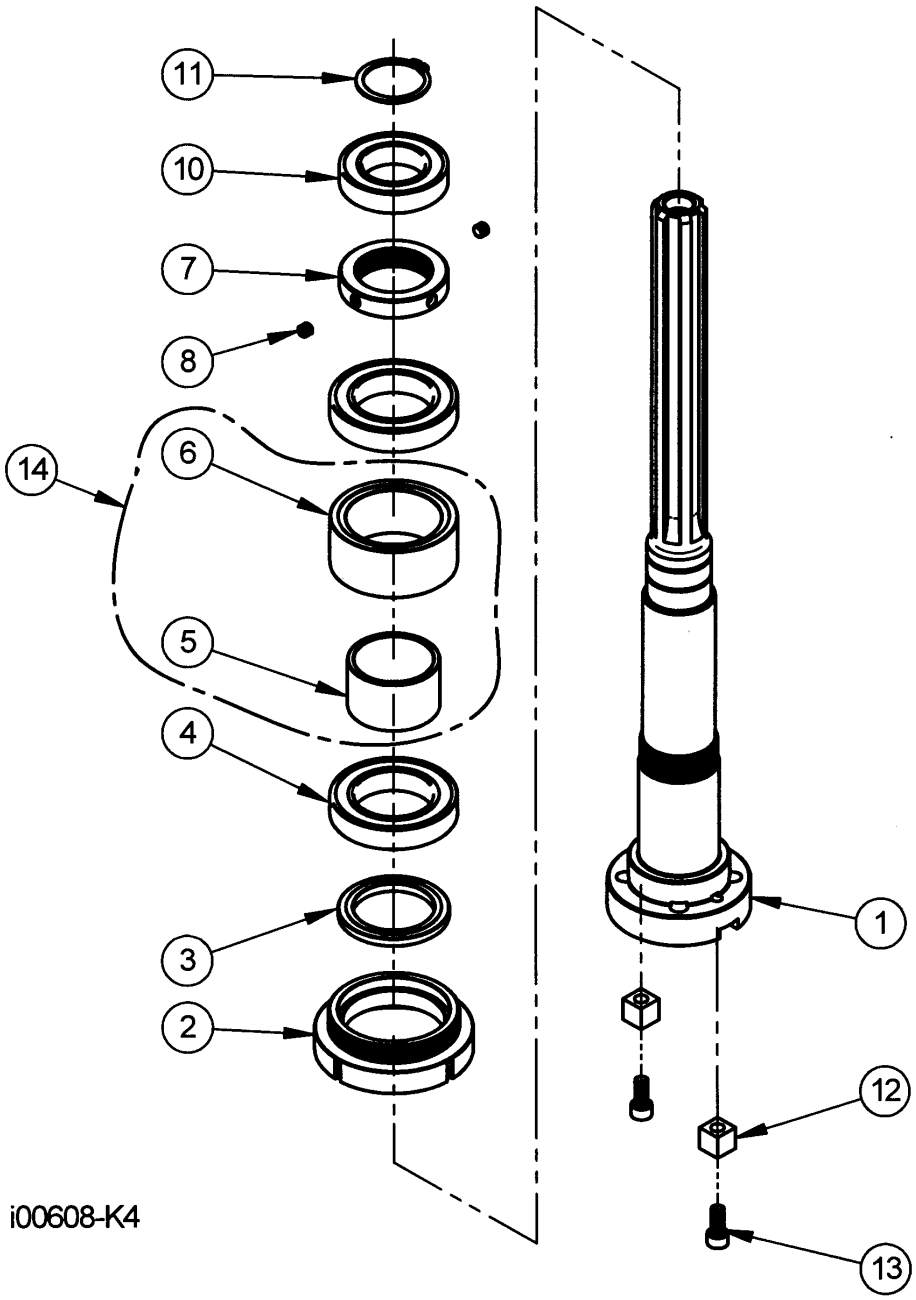


Figure 115
Quill Spindle Sub-Assembly
P/N: 20836-1

Parts List - Spindle Sub-Assembly

Item	P/N	DESCRIPTION	Qty
1	FB127	SPINDLE BT-40	1
2	FB133	NOSE-PIECE	1
3	FB134	SPINDLE DIRT SHIELD	1
4	20839	BEARING (7010CP4) SET of 2	1 Set
5	FB136	BEARING SPACER-LARGE	1
6	FB137	BEARING SPACER-SMALL	1
7	FB139	SPINDLE BEARING KNOCK NUT	1
8	FB139-1	SET SCREW M8-P1.25x6L	2
10	A112H	BEARING 6008ZZ	1
11	FB143	LOCK RING Ø 40	1
12	FB140	SPINDLE FIXED NUT	2
13	FB141	COLLET ALIGNMENT SCREW M8-P1.25x20L	2
14	20841	BEARING SPACER SET	1

i00608-K4

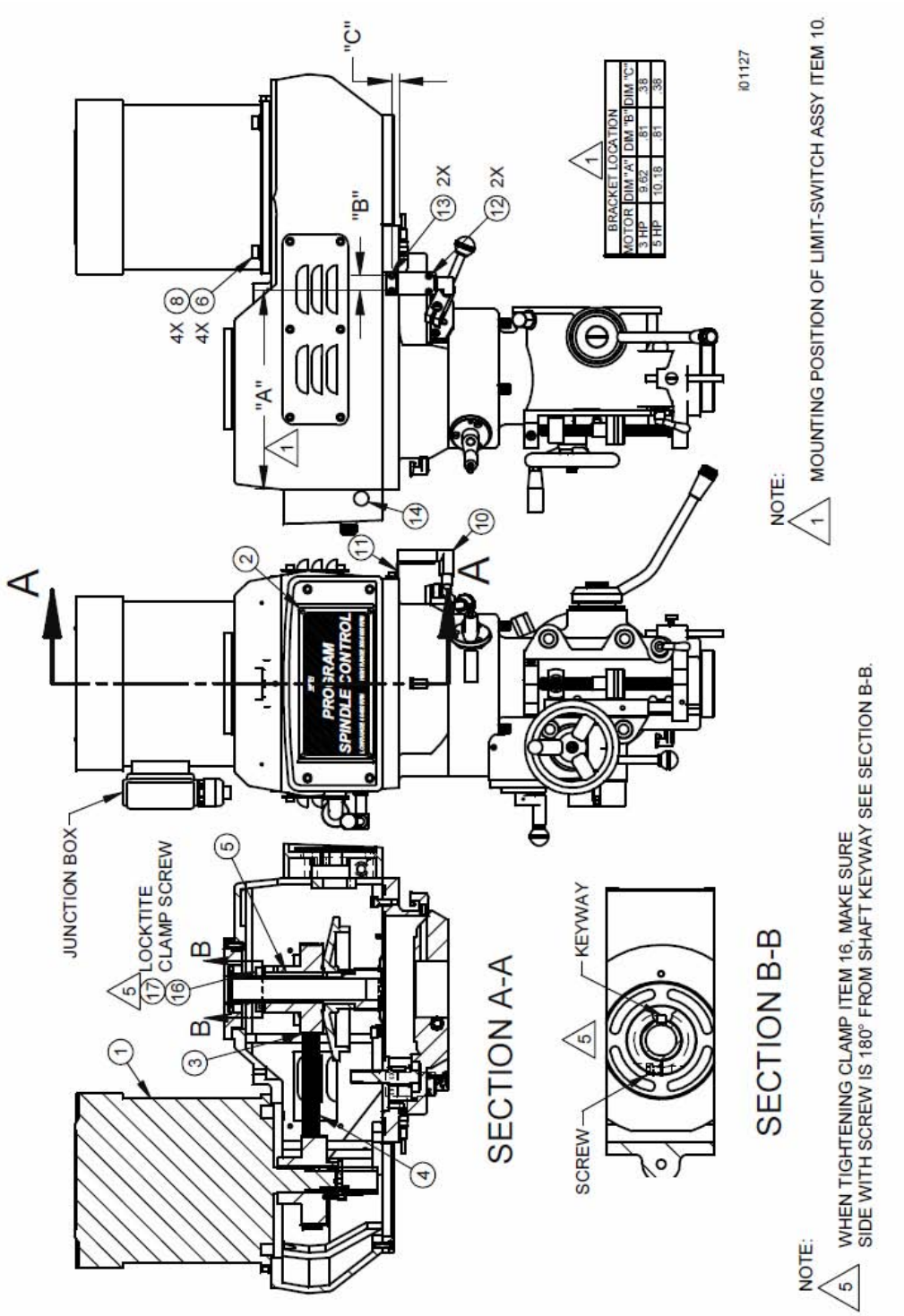


Figure 116
Head Top Assembly with Spindle Control Option

Parts List - Head Top Assembly – K4SX with Spindle Control Option

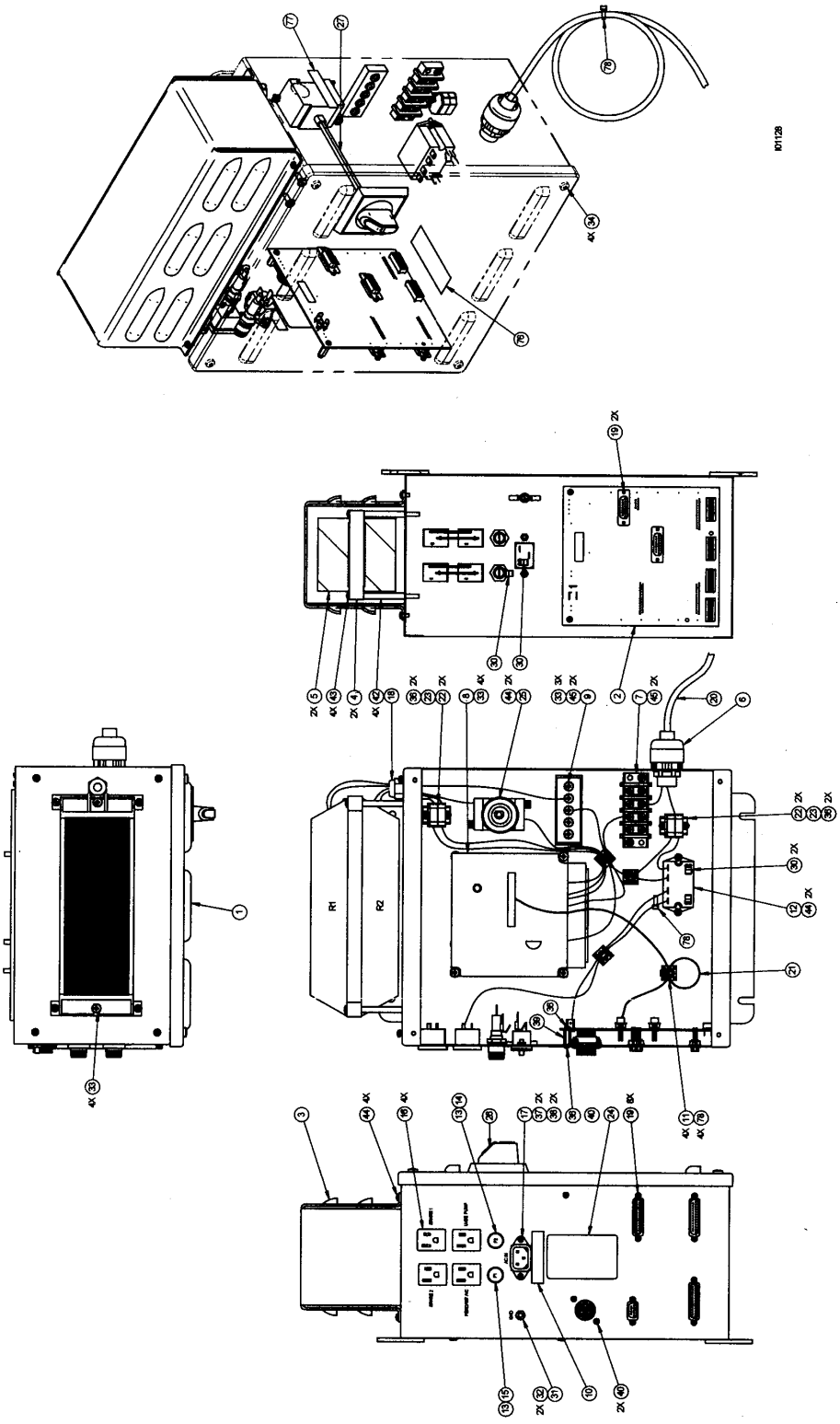
Item	P/N	DESCRIPTION	Qty
1	24163	MOTOR ASSY-SPINDLE-5 HP	1
2	23965	NAMEPLATE - E-HEAD OPTION	1
3	23967	PULLEY - SPINDLE - NT 40	1
4	23597	BELT-MICRO-V-J PROFILE 10 RIBS "J"	1
5	24169	KEY 8 mm X 8 mm	1
6	3/8 70P	WASHER-FLAT USS-STL-BO	4
8	3/8-16X1 1/4 24B	SCREW-HEX HEAD-STL-BO	4
10	23968	SWITCH ASSY- LIMIT-HI/LOW	1
11	23969-2	BRACKET - GEAR SWITCH-5 HP	1
12	M4-0.7X16 25B	SCREW-SHCS-STL-BO	2
13	M5-0.8X12 25B	SCREW-SHCS-STL-BO	2
14	24164	PLUG-PRY-OUT	1
17	24172 or 23986-2	COLLAR-LOCK CCM-050	1

I01127-K4

Parts List – Head Top Assembly – K2SX/K3SX with Spindle Control Option

Item	P/N	DESCRIPTION	Qty
1	24162	MOTOR-SPINDLE-ASSY-3 HP	1
2	23965	NAMEPLATE - E-HEAD OPTION	1
3	23632	PULLEY - SPINDLE- R8	1
4	23597	BELT-MICRO-V-J PROFILE 10 RIBS "J"	1
5	24169	KEY 8 mm X 8 mm	1
6	3/8 70P	WASHER-FLAT USS-STL-BO	4
8	3/8-16X1 1/4 24B	SCREW-HEX HEAD-STL-BO	4
10	23968	SWITCH ASSY- LIMIT-HI/LOW	1
11	23969-1	BRACKET - GEAR SWITCH-3 HP	1
12	M4-0.7X16 25B	SCREW-SHCS-STL-BO	2
13	M5-0.8X12 25B	SCREW-SHCS-STL-BO	2
14	24164	PLUG-PRY-OUT	1
16	24172-1 or 23986-1	COLLAR-CLAMP	1

I01127-K2-K3



PART #	DESCRIPTION
24060-1	SPINDLE CONTROL-3HP
24060-2	SPINDLE CONTROL-5HP

i01128

Figure 117
Electrical Enclosure-Spindle Control Option

Parts List – Electrical Enclosure – K4SX with Spindle Control Option

Item	P/N	DESCRIPTION	Qty
2	24063-3	PCB ASSY-SMX-SPINDLE CONTROL	1
5	22890-500-64	RESISTOR-500W-64ohm (5 HP MACHINES)	2
7	23433-04	TERMINAL BLOCK 4 POLE	1
8	25106-K4SX	AC DRIVE - 5 HP MINI VECTOR-220V	1
12	22961	RELAY-POWER - 115V DPST	1
13	21820	FUSE HOLDER	2
14	21824-5	FUSE-3AG-SLOW BLOW 5 AMP	1
15	21824-8	FUSE-3AG-SLOW BLOW 8 AMP	1
16	22199	RECEPTACLE- PANEL MOUNT NEMA STD 15A 125V	1
17	21827	SNAP RING 35X1.5	1
21	22443	CABLE ASSY-PT4 VL/VM 15 PIN SPINDLE CONTROL	1
25	24182	DISCONNECT SWITCH	1
26	24183	ROD-DISCONNECT/HANDLE	1

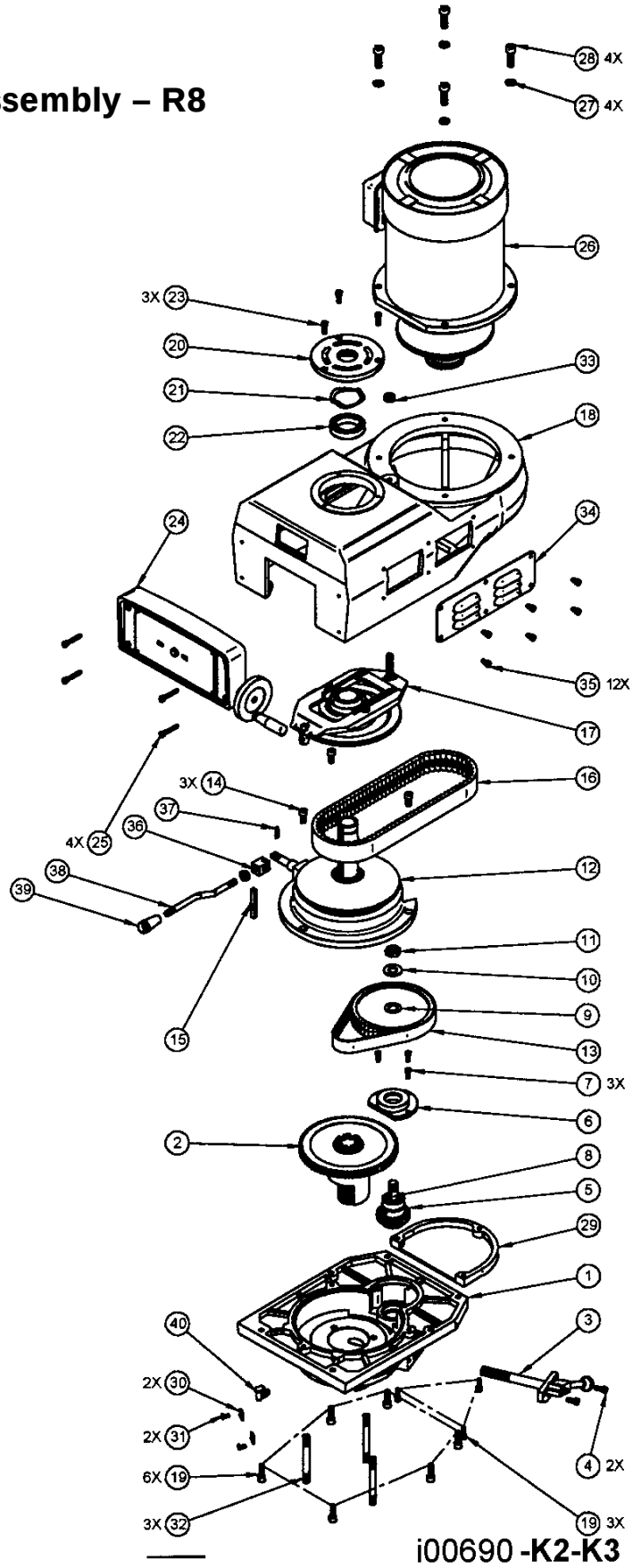
i01128-K4

Parts List – Electrical Enclosure – K2SX/K3SX with Spindle Control Option

Item	P/N	DESCRIPTION	Qty
2	24063-3	PCB ASSY-SMX-SPINDLE CONTROL	1
3	24066	SHEETMETAL-RESISTOR COVER	1
5	22890-500-120	RESISTOR-500W-120ohm (3 HP MACHINES)	2
7	23433-04	TERMINAL BLOCK 4 POLE	1
8	25105-K2/K3SX	AC DRIVE - 3 HP MINI VECTOR-220V	1
12	22961	RELAY-POWER - 115V DPST	1
13	21820	FUSE HOLDER	2
14	21824-5	FUSE-3AG-SLOW BLOW 5 AMP	1
15	21824-8	FUSE-3AG-SLOW BLOW 8 AMP	1
16	22199	RECEPTACLE- PANEL MOUNT NEMA STD 15A 125V	1
17	21827	RECEPTACLE-AC INPUT	1
21	22443	CABLE ASSY-PT4 VL/VM 15 PIN SPINDLE CONTROL	1
25	24182	DISCONNECT SWITCH	1
26	24183	DISCONNECT/HANDLE	1

i01128-K2-K3

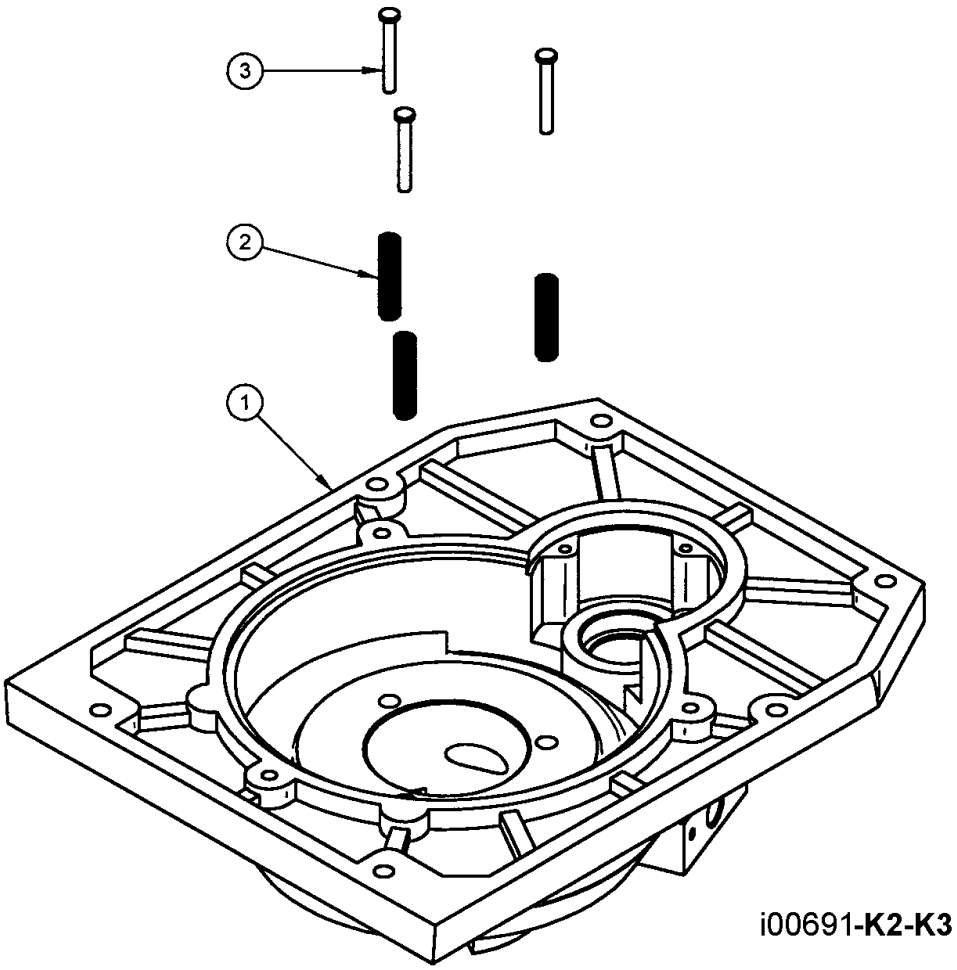
Figure 118
Top Housing Assembly – R8



Parts List
Head Top Assembly - 24692

Item	P/N	Title	Qty
1	20778-1	GEAR HOUSING SUB-ASSY (3VK-A1)	1
2	20778-2	HI-LOW SHIFT CLUTCH SUB-ASSY (3VK-A2)	1
3	20778-3	HI-LOW SHIFT SUB-ASSY (3VK-A3)	1
4	VS12	SOCKET CAP SCREW M6-P1.0x15L	2
5	20778-4	PULLY PINION SUB-ASSY (3VK-A4)	1
6	VS64	BULL GEAR PINION BEARING CAP	1
7	VS93	SCREW M5-P0.8x15L	1
8	VS117	KEY 5x525L	1
9	VS62	TIMING BELT PULLEY	1
10	VS126	WASHER Ø 5/8	1
11	VS61	JAM NUT 5/8-11NC	1
12	20778-5	LOWER VARI-DISC DRIVE SUB-ASSY (3VK-A5)	1
13	VS63	BELT 3/8"-#225	1
14	VS14-1	SCREW M8-P1.25x18L	3
15	VS135	KEY 8x7x60L	1
16	VS4	BELT	1
17	20778-6	UPPER VARI-DISC DRIVE SUB-ASSY (3VK-A6)	1
18	VS1	BELT HOUSING	1
19	VS137	SOCKET CAP SCREW M8-P1.25x25L	1
20	VS13	TOP BEARING CAP	1
21	VS13-1	WAVE WASHER	1
22	VS15	BEARING-DEEP GROVE-6007V	1
23	VS129	SCREW- SOC HD CAP M6-P1.0x18L	1
24	20778-7	SPEED CHANGE HANDWHEEL SUB-ASSY (3VK-A7)	1
25	VS07	SCREW- SOC HD CAP M6-P1.0x35L	1
26	20819	MOTOR ASSY- K2 & K3- 3HP (reference only, not part of upper head housing assembly)	1
27	VS130	WASHER- FLAT Ø 10.2	4
28	VS111	SOC HD SCREW- 3/8-16NCx32L	4
29	VS11	MOTOR PULLEY COVER	1
30	VS104	COPPER CHIP(2REQ.)	2
31	VS131	SCREW- FLAT HD PHILIP M5-P0.8x10L	1
32	VS132	STUD Ø 7/16-100L	2
33	VS96	JAM NUT 3/8"-16NC	1
34	VS101	VENTILATOR(2REQ.)	2
35	VS136	SCREW- SOC HD CAP M6-P1.0x10L	12
36	VS54	HANDLE FIX BLOCK	1
37	VS55	SET SCREW	1
38	VS56	BRAKE LOCK HANDLE	1
39	VS57	BAKELITE BALL HANDLE	1
40	OIL-1	OIL CUP	1

i00690-K2-K3

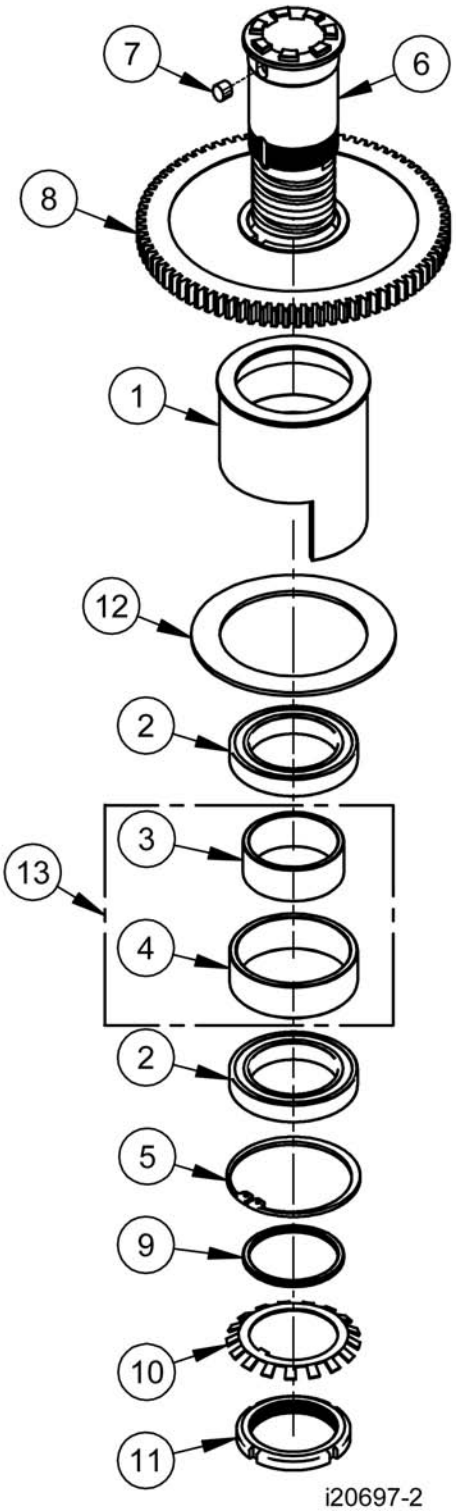


Item	P/N	Title	Qty
1	VS82	GEAR HOUSING	1
2	VS112	GUIDE SPRING	3
3	VS113	SPRING GUIDE PIN	3

i00691-K2-K3

Figure 119
Gear Housing
P/N: 20778-1

Figure 120
Hi-Low Shift Clutch
Sub-Assembly
P/N: 20778-2



Parts List – High-Low Shift Clutch

Item	P/N	DESCRIPTION	Qty
1	VS75	BEARING SLIDING HOUSING	1
2	23970	BALL BEARING 6908ZZ	1 SET
3	VS78	BEARING SPACER	1
4	VS79	BEARING SPACER	1
5	VS80	SNAP RING R-65	1
6	VS73	SPLINED GEAR HUB	1
7	VS72	KEY 8x7x10L	1
8	VS74	SPINDLE BULL GEAR	1
9	VS114	WASHER	1
10	VS115	EXTERNAL TOOTH WASHER Ø 40	1
11	VS81	LOCK WASHER Ø 9/16-18NC	1
12	VS76	RING	1
13	20817	SPACER-BEARING	1

i00692-K2-K3

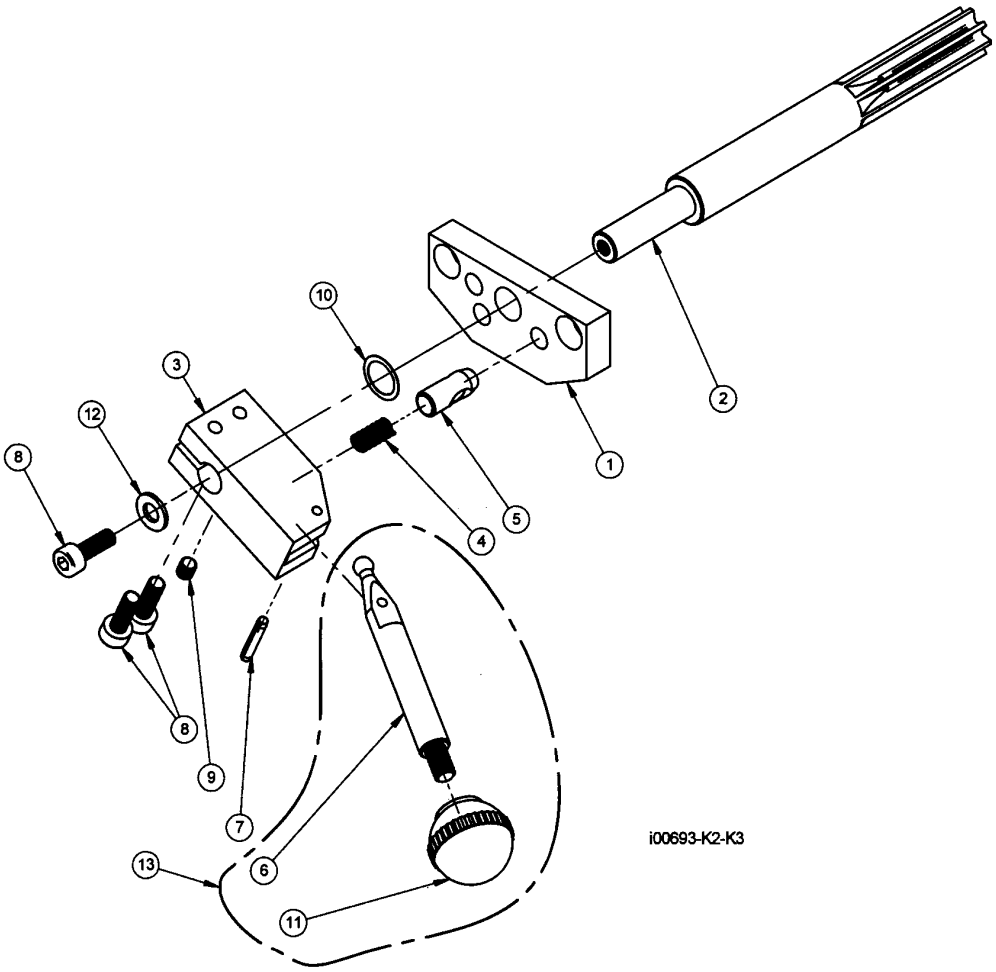
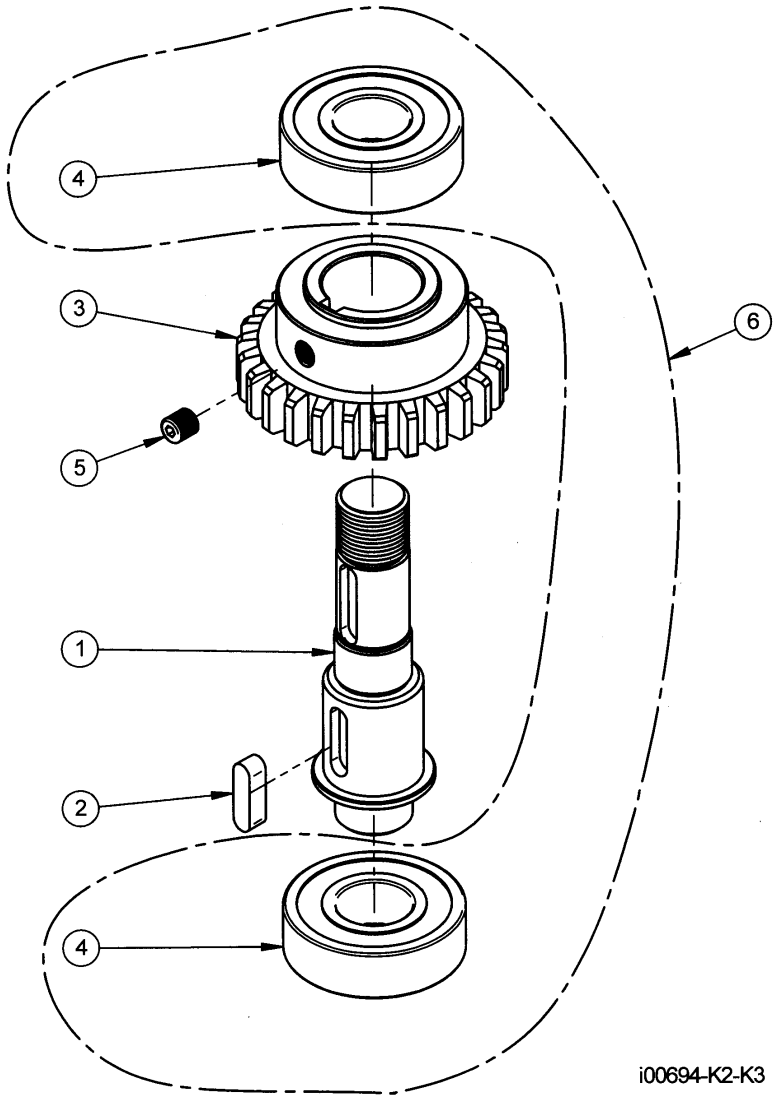


Figure 121
Hi-Low Shift
P/N: 20778-3

Item	P/N	DESCRIPTION	Qty
1	VS89	HI-LOW DETENT PLATE	1
2	VS87	CLUTCH GEAR SHAFT	1
3	VS92	HI-LOW PINION BLOCK	1
4	VS91	SPRING	1
5	VS90	HI-LOW DETENT PLUNGER	1
7	VS88	PIN Ø 3X19L	1
8	VS93	SCREW M5-P0.8x15L	2
9	VS92-1	SET SCREW M5-P0.8x5L	1
10	VS92-2	WASHER- FLAT Ø 11	1
12	VS116	WASHER- FLAT Ø M5	1
13	24083	SHAFT-HI/LOW SHAFT ASSY	1

i00693-K2-K3



Item	P/N	DESCRIPTION	Qty
1	VS67	BULL GEAR PINION COUNTER SHAFT	1
2	VS69	KEY 5X5X18L	1
3	VS66	BULL GEAR PINION	1
4	AK118	BALL BEARING (2 REQ.) 6203ZZ	2
5	VS3	SOCKET SET SCREW M6-P1.0x6L	1
6	23954	BEARING-DEEP GROOVE-SET (2)-6203ZZ	1

i00694-K2-K3

Figure 122
Pulley Pinion
P/N: 20778-4

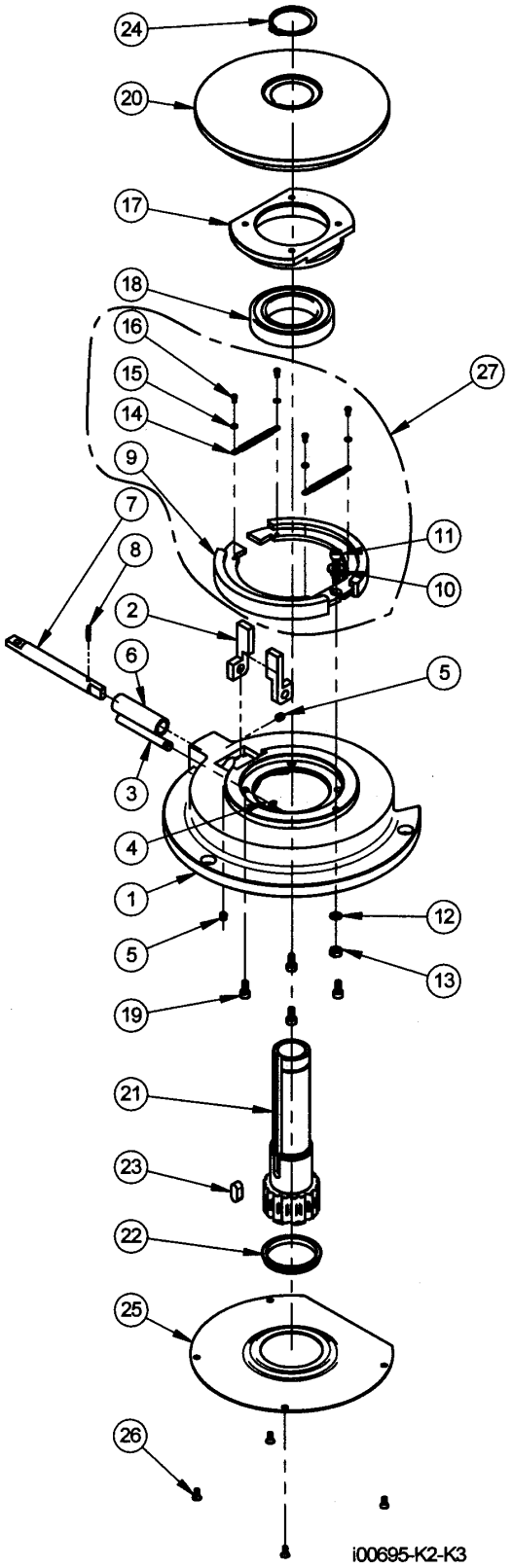


Figure 123
Lower Vari-Disc Drive
P/N: 20778-5

(assembly not available, order parts separately)

Parts List – Lower Vari-Disc Drive

Item	P/N	DESCRIPTION	Qty
1	VS50	BELT HOUSING BASE	1
2	VS59	BRAKE BLOCK	2
3	VS58	TURNING BLOCK SHAFT	1
4	VS103	RETAINING RING Ø 7	1
5	VS51	SET SCREW M6-1.0X6L	2
6	VS53	BRAKE LOCK BUSHING	1
7	VS52	BRAKE LOCK SHAFT	1
8	VS52-2	BRAKE LOCK PIN DIA 3 X 5/8"L	1
9	VS47	BRAKE SHOE	2
10	VS48	BRAKE SHOE PIVOT SLEEVE	1
11	VS17	SOCKET CAP SCREW M6-P1.0x35L	1
12	VS17-1	WASHER Ø 6	1
13	VS17-2	NUT M6-P1.0	1
14	VS49	BRAKE SPRING	2
15	VS122	WASHER DIA 3.3	4
16	VS120	SCREW-PAN HEAD PHILIP 5-40NC	4
17	VS46	BRAKE BEARING CAP	1
18	VS43-1	BALL BEARING 6010ZZ	1
19	VS14	SOCKET CAP SCREW M5-0.8x12L	4
20	VS45	STATIONARY DRIVEN VARIDISC	1
21	VS70	SPINDLE PULLY ASSY	1
22	VS100	SPINDLE PULLY SPACER	1
23	VS71	KEY 8x7x20L	1
24	VS97	SNAP RING Ø 40	1
25	VS50-1	DUST COVER	1
26	VS50-2	SCREW-FH-PH-STL-BO M6-1.0X6L	4
27	24055	BRAKE SHOE ASSY	1

i00695-K2-K3

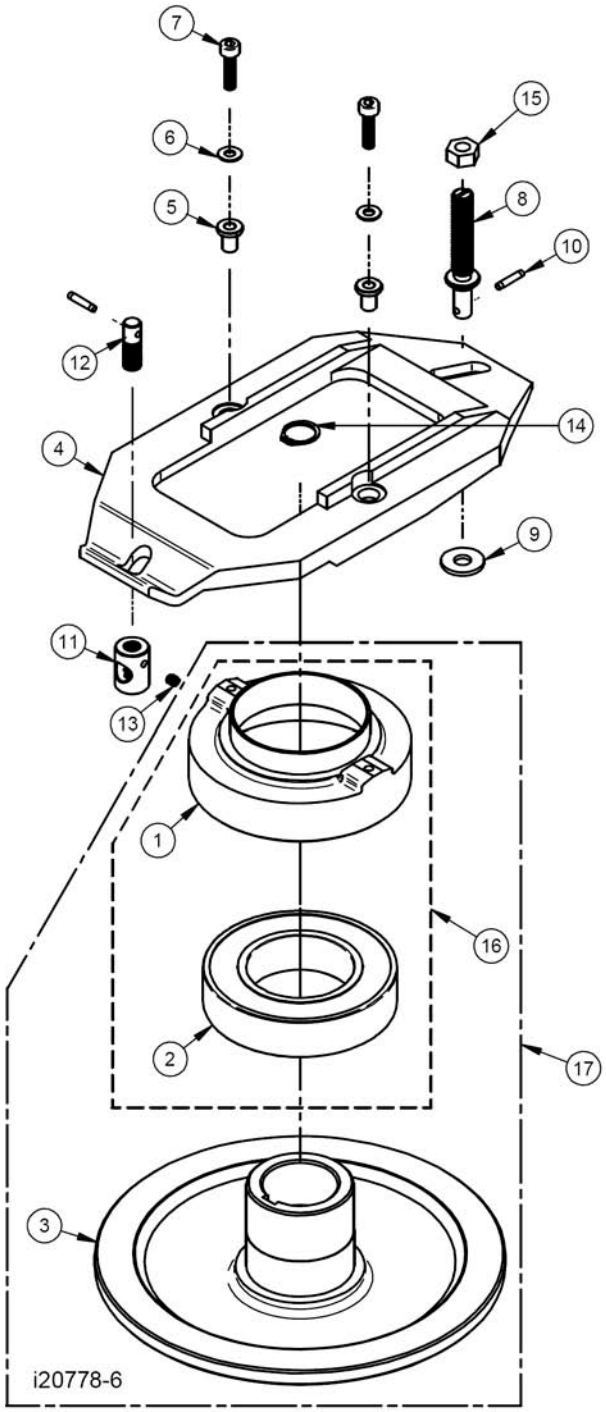
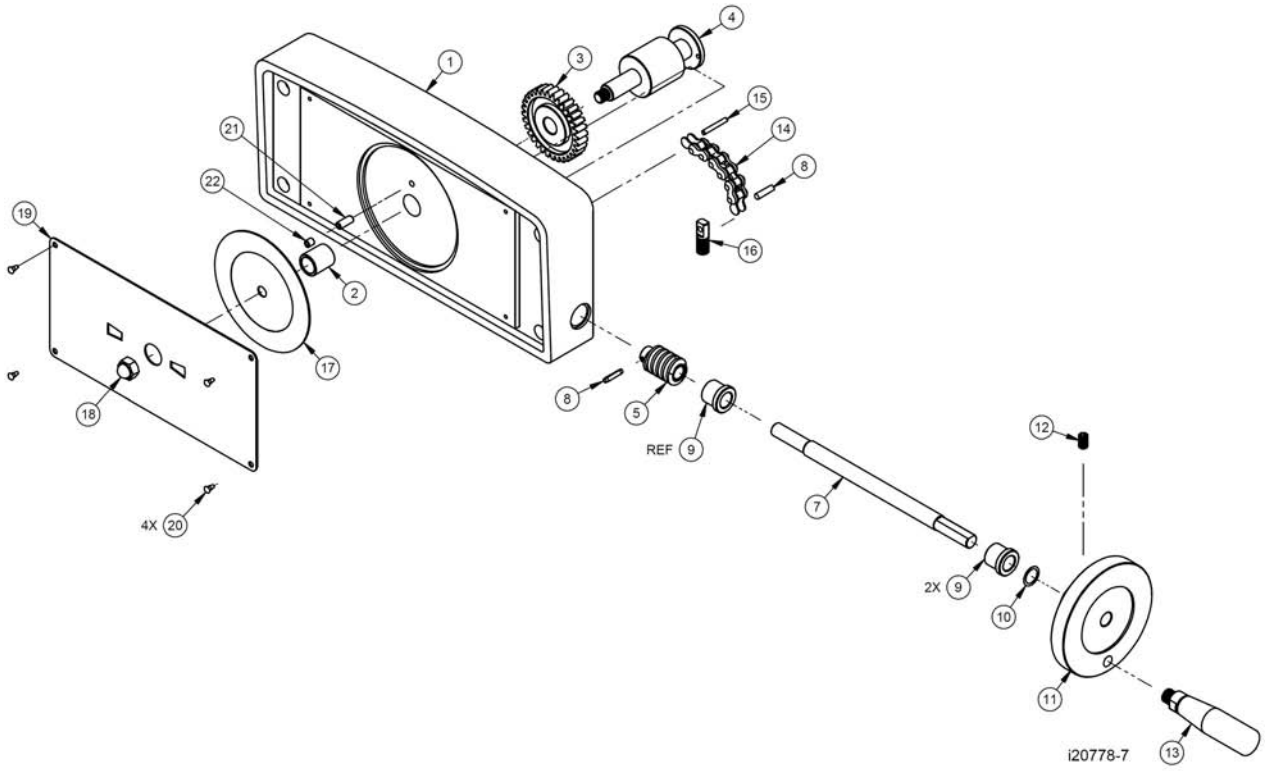


Figure 124
Upper Vari-Disc Drive Sub-Assy
P/N: 20778-6

Parts List – Upper Vari-Disc Drive Sub-Assy

Item	P/N	DESCRIPTION	Qty
1	VS42	SPINDLE PULLEY BEARING HOUSING	1
2	VS43	BALL BEARING 6210ZZ	1
3	VS44	ADJUSTABLE-DRIVEN VARIDISC	1
4	VS36	SPEED CHANGE PLATE	1
5	VS38	PIVOT SLEEVE Ø 5	2
6	VS37	WASHER M5-P0.8x20L	2
7	VS123	SCREW-SHCS M5-0.8X20L	2
8	VS39	SPEED CHANGE PLATE PIVOT STUD	1
9	VS41	WASHER Ø 8.2	1
10	VS40	ROLL PIN Ø3x15L	2
11	VS35	ADJUSTMENT NUT	1
12	VS34	CHAIN END STUD	1
13	VS33	CHAIN FRONT SCREW M4-P0.7x5L	1
14	VS7	SNAP RING Ø 35	1
15	FVS96	JAM NUT 3/8-16NC	1
16	24564	BEARING HOUSING ASSY	1
17	24631	VARI DISC ADJUSTABLE ASSY	1

i20778-6



Item	P/N	DESCRIPTION	Qty
1	VS16	SPEED CHANGE HOUSING	1
2	VS20	BEARING SELF LUBRICATING	1
3	VS22	SPEED CHANGER GEAR	1
4	VS31	SPEED CHANGE CHAIN DRUM	1
5	VS21	WORM	1
7	VS25	SPEED CHANGE SHAFT	1
8	VS40	ROLL PIN Ø3x15L	2
9	VS24	COPPER BUSHING	2
10	VS24-1	WASHER-WAVE	1
11	VS27	SPEED CHANGE HANDWHEEL	1
12	VS18	FULL DOG SOCKET SET SCREW M6-P1.0x10L	1
13	VS28	HANDLE 3/8-16NC	1
14	VS32	CHAIN #310X9.525	1
15	VS31-1	DOWEL PIN Ø3x25L	1
16	VS30	SPEED CHANGE STUD	1
17	VS16-1	SPEED DIAL	1
18	VS95	NUT-ACORN 5/16-18 NC	1
19	VS16-2	NAME PLATE	1
20	VS19	SCREW-DRIVE	4
21	M5-0.8X14 40B	SCREW-SOC SET-STL-BO-CUP	1
22	M5-0.8X5 40B	SCREW-SOC SET-STL-BO-CUP	1

i20778-7

Figure 125
Speed Change Handwheel
P/N: 20778-7

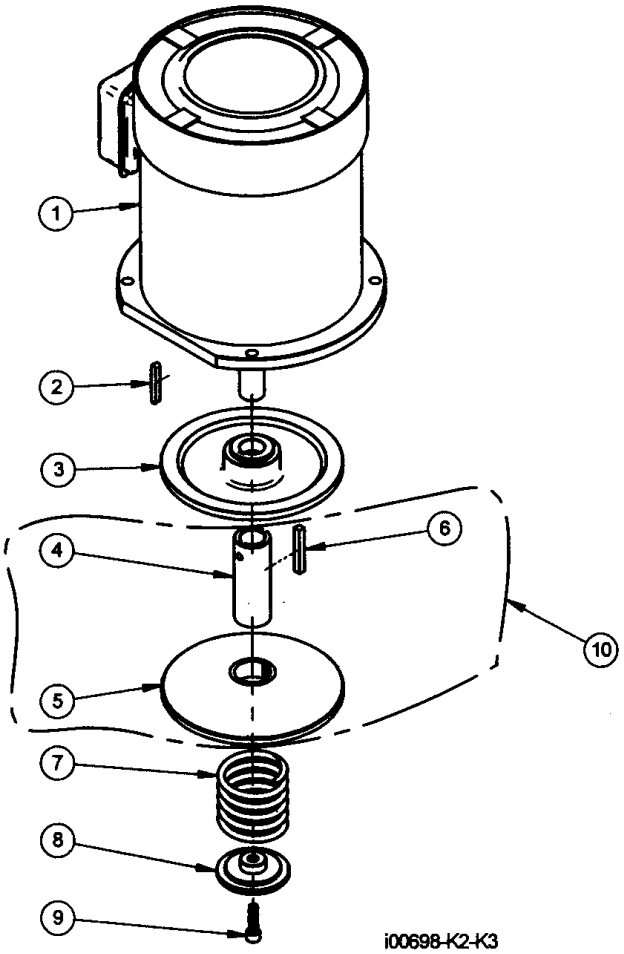


Figure 126
Spindle Motor
P/N: 20819

Item	P/N	DESCRIPTION	Qty	Notes
1	VS110	MOTOR 3 HP	1	only available as 20819
2	VS3-1	KEY 6x6x45L	1	only available as 20819
3	VS2	STATIONARY MOTOR VARIDISC	1	only available as 20819
4	VS6	BUSHING	1	available as 23953 or 20819
5	VS5	ADJUSTABLE MOTOR VARIDISC	1	available as 23953 or 20819
6	VS6-1	KEY 7x7x50L	1	available as 23953 or 20819
7	VS8	SPRING FOR VARIDISC MOTOR SHAFT	1	only available as 20819
8	VS9	ADJUSTABLE VARIDISC SPRING COLLAR	1	only available as 20819
9	VS10	SCREW- SOC HD CAP M8-P1.25x30L	1	only available as 20819
10	23953	VARIDISC ASSY-ADJUSTABLE MOTOR	1	

i00698-K2-K3

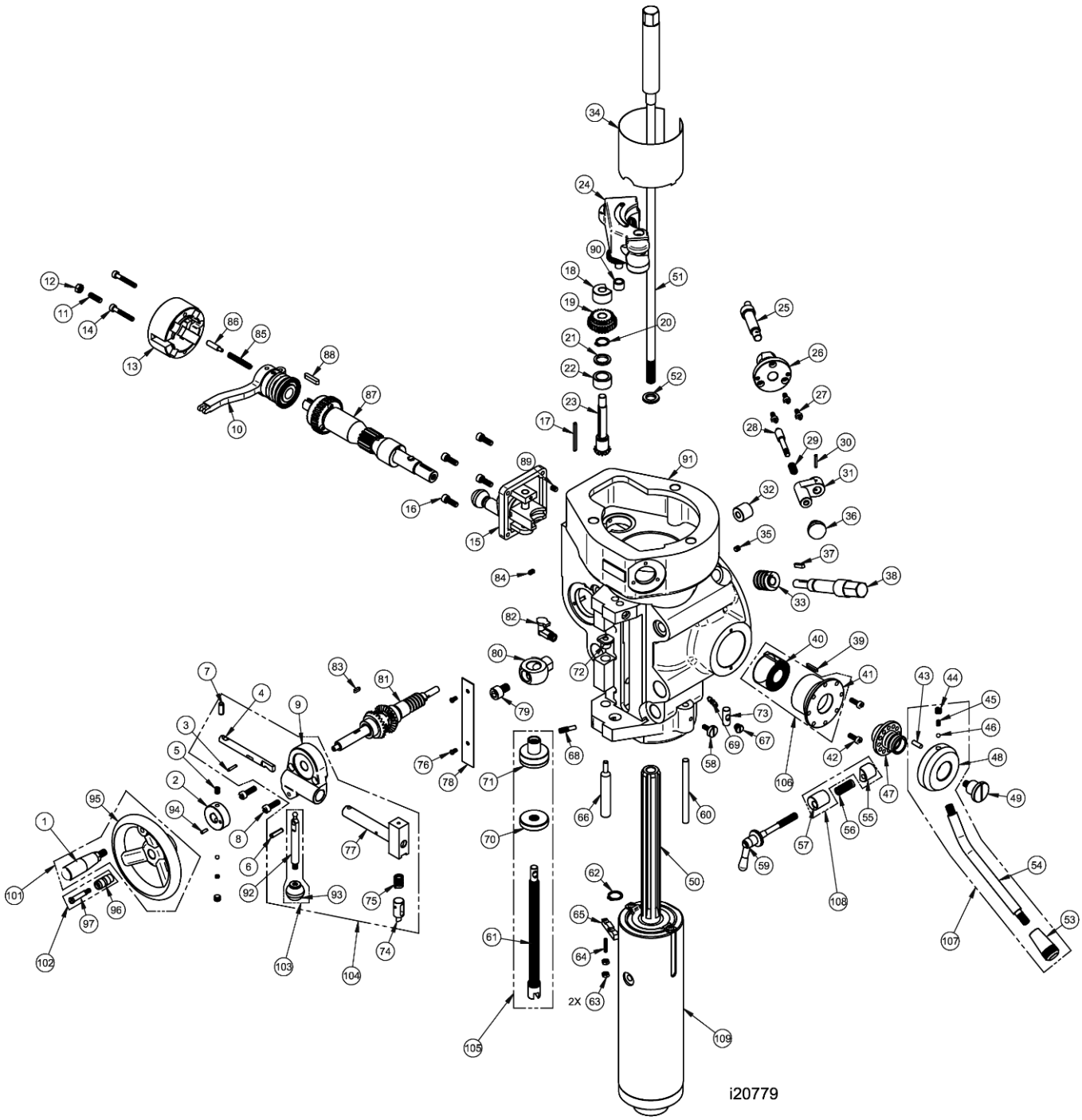


Figure 127
Lower Head Assembly

Parts List – Lower Head Assembly

Item	P/N	Title	Qty
1	K-B125-2	HANDWHEEL HANDLE (AVAILABLE ONLY IN ASSY. 20835)	1
2	K-B113	HAND WHEEL CLUTCH	1
3	K-B117	ROLL PIN Ø3x15L	1
4	K-B103	CAM ROD	1
5	K-B108	SOCKET SET SCREW M6-P1.0x8L	1
6	K-B119-1	ROLL PIN Ø3x20L	1
7	K-B103-1	CAM ROD PIN Ø6x15L	1
8	K-B107	CAP SCREW M6-P1.0x25L	2
9	K-B106	FEED TRIP BRACKET	1
10	20779-4	OVERLOAD CLUTCH TRIP SUB-ASSY (3VK-B4)	1
11	K-B73	SOCKET SET SCREW M6-P1.0x20L	1
12	K-B101	CHEM BLACKED LOCKNUT M6-P1.0	1
13	K-B99	CLUTCH ARM COVER	1
15	20779-2	QUILL FEED SELECTOR SUB-ASSY (3VK-B2)	1
16	K-B67	CAP SCREW M6-P1.0x18L	4
17	K-B29	CLUSTER GEAR KEY 3x3x45L	1
18	K-B27	CLUSTER GEAR SHAFT UPPER BEARING	1
19	K-B28	CLUSTER GEARS ASSEMBLY	1
20	K-B94	SNAP RING 95 DOWEL PIN Ø 14	1
21	K-B32	BEVEL GEAR THRUST SPACER	1
22	K-B33	BEVEL GEAR BEARING	1
23	K-B31	CLUSTER GEAR SHAFT 6602BB	1
24	20779-1	WORM GEAR CRADLE SUB-ASSY (3VK-B1)	1
25	K-B18	WORM GEAR CRADLE THROW-OUT	1
26	K-B19	SHIFT SLEEVE	1
27	K-B25	CAP SCREW(3REQ.) M5-P0.8x12L	3
28	K-B20	GEAR SHIFT PLUNGER	1
29	K-B21	COMPRESSION SPRING	1
30	K-B22	ROLL PIN Ø3x20L	1
31	K-B23	SHIFT CRANK	1
33	K-B186	WORM GEAR	1
34	K-B128	QUILL SKIRT	1
35	K-B189-1	ADJ WORM SHAFT SET SCREW M6-P1.0x6L	1
36	K-B42	BUSHING	2
37	K-B187	KEY 4x4x18L	1
38	K-B189	ADJ WORM SHAFT	1
39	K-B171	KEY 3x3x20L	1
40	K-B178	CLOCK SPRING(CLOCK SPRING ASSY.)	1
41	K-B177	SPRING COVER	1
42	K-B169	RD.HEAD SCREW(2REQ.) M5-P0.8x15L	2
43	K-B170	ROLL PIN	1
44	K-B175-3	SET SCREW M8-P1.25x6L	2
45	K-B175-2	COMPRESSION SPRING	2
46	K-B175-1	STEEL BALL	2
47	K-B176	PINION SHAFT HUB SLEEVE	1
48	K-B175	RACK FEED HANDLE HUB	1

49	K-B172	PINION SHAFT HUB SEREW	1
50	20836	SPINDLE ASSY-R8	0
51	VS109	DRAWBAR 7/16-20UNF	1
52	VS109-1	SPACER	1
53	K-B191	BLACK PLASTIC BALL HANDLES (sold as assy 20849 only)	1
54	K-B190	PINION SHAFT HUB HANDLE (sold as assy 20849 only)	1
55	K-B148	QUILL LOCK SLEEVE	1
56	K-B148-1	COMPRESSION SPRING	1
57	K-B153	QUILL LOCK SLEEVE TAPPED	1
58	KB-201	INDICATOR ROD SCREW	1
59	K-B149	LOCK HANDLE	1
60	KB-202	INDICATOR ROD	1
61	K-B164	QUILL STOP MICRO-SCREW	1
62	K-B160	SNAP RING Ø16	1
63	K-B124-2	FEED TRIP PLUNGER NUT M40-P0.7	2
64	K-B124-1	FEED TRIP PLUNGER SOC SET SCREW M4-P0.7x20L	1
65	K-B145	FEED TRIP LEVER	1
66	K-B124	FEED TRIP PLUNGER	1
67	K-B185	REVERSE TRIP BALL LEVER SCREW	1
68	K-B144	SOCKET SET SCREW	1
69	K-B183	REVERSE TRIP BALL LEVER	1
70	K-B161	QUILL MICRO-STOP NUT	1
71	K-B162	MICROMETER NUT	1
72	K-B123	TRIP PLUNGER BUSHING	1
73	K-B184	FEED REVERSE TRIP PLUNGER	1
74	K-B121	TRIP PLUNGER	1
75	K-B120	COMPRESSION SPRING	1
76	K-B158	CHEM BLACKED RD.HD.SCREWS(2 REQ.) M5-P0.8x8L	2
77	K-B118	CAM ROD SLEEVE ASSY	1
78	K-B159	MICROMETER SCALE	1
79	KB-200	SCREW- SOC HD 3/8-24NFx15L	1
80	K-B163	QUILL STOP KNOB	1
81	20779-5	FEED REVERSE CLUTCH SUB-ASSY (3VK-B5)	1
82	OIL-1	OIL CUP	1
83	K-B109	KEY 3x3x20L	1
84	K-B17-1	WORM GEAR SET SCREW M6-P1.0x8L	1
85	K-B88-1	COMPRESSION SPRING	1
86	K-B89	OVERLOAD CLUTCH LEVER SPRING PLUNGER	1
87	20779-3	SUB - ASSY - QUILL PINION SHAFT - R8	1
88	K-B167	KEY 5x5x25L	1
89	K-B27-1	SET SCREW M6-P1.0x8L	1
90	K-B41	NEEDLE BEARING BA66 BEARING SIZE KO-BA66Z	1
91	K-B192	QUILL HOUSING	1
92	K-B104	TRIP HANDLE	1
93	K-B105	BLACK PLASTIC BALL	1
94	K-B125-1	HANDWHEEL SPRING PIN Ø3x3x10L	1
95	K-B125	HANDWHEEL	1
96	K-B111	REVERSE KNOB	1
97	K-B100	CAP SET SCREW M5-P0.8x35L	3

98	25042	SCALE-HEAD ROTATION-R8	1
99	25043	POINTER SCALE	1
100	25044	DRIVE SCREW-SCALE	4
101	20835	HANDWHEEL ASSY	1
102	20834	FEED REVERSE KNOB ASSY	1
103	24052	TRIP HANDLE ASSEMBLY (INCLUDES PLASTIC BALL)	1
104	20832	FEED TRIP ASSY	1
105	20847	QUILL MICRO NUT & SCREW ASSY	1
106	24051	CLOCK SPRING ASSEMBLY (SPRING & COVER)	1
107	20849	FEED HANDLE ASSY (QUILL HANDLE)	1
108	20843	QUILL LOCK SLEVE ASSY	1
109	K-B142	QUILL	1
110	K-B155	T BOLT ASSY (not shown on drawing)	1

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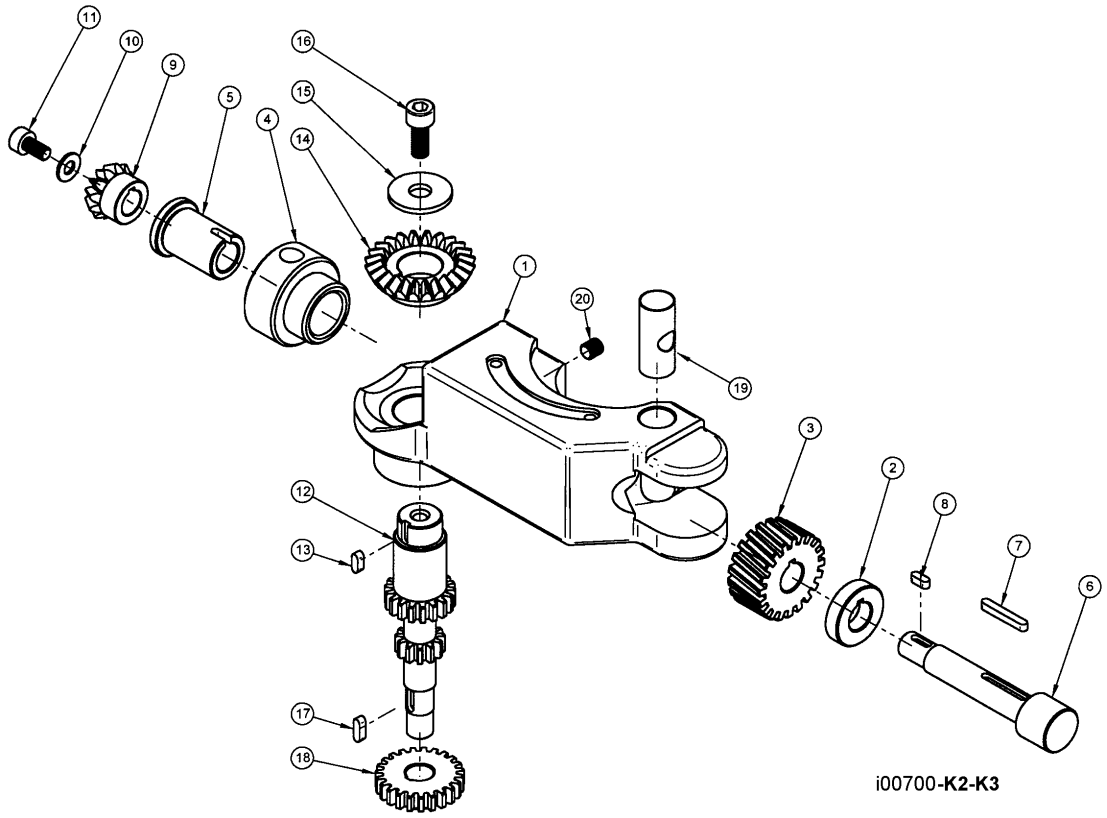
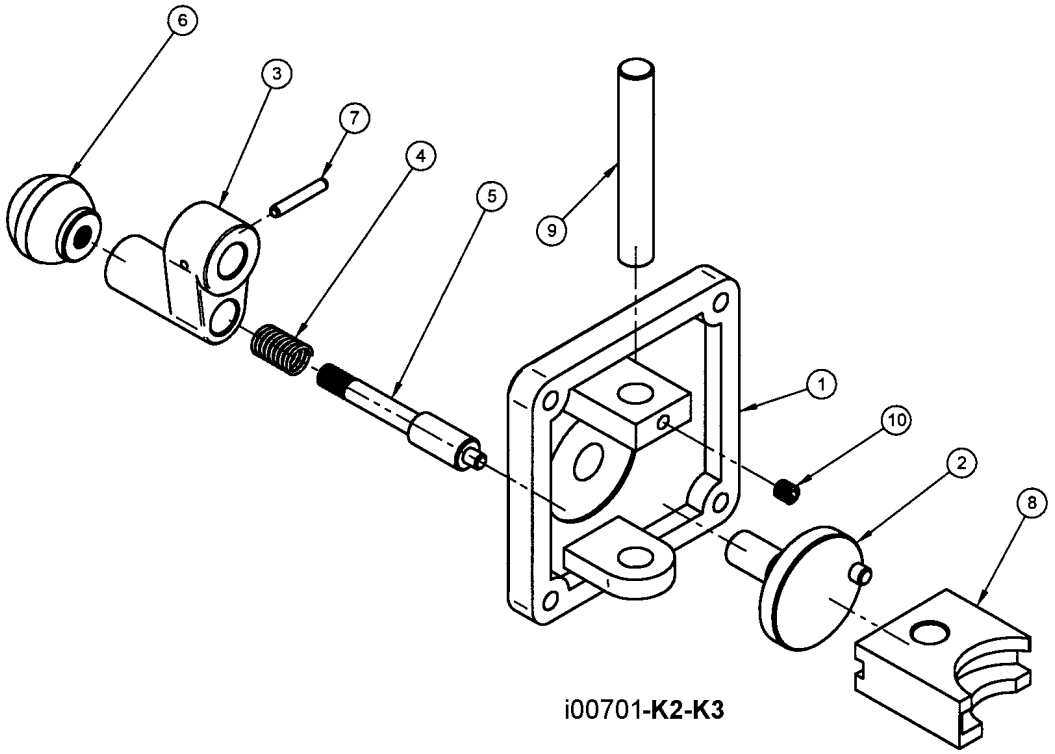


Item	P/N	Title	Qty
1	K-B17	WORM GEAR CRADLE	1
2	K-B07	WORM GEAR SPACER	1
3	K-B08	FEED DRIVEWORM GEAR	1
4	K-B05	WORM CRADLE BUSHING	1
5	K-B04	FEED WORM GEAR SHAFT SLEEVE	1
6	K-B09	FEED DRIVE WORM GEAR SHAFT	1
7	K-B11	KEY 3x3x25L	1
8	K-B10	WORM SHAFT KEY 3x3x8L	1
9	K-B03	FEED BEVEL PINION	1
10	K-B02	BEVEL PINION WASHER Ø 5	1
11	K-B01	SOC.HD.SCREW M5-P0.8x10L	1
12	K-B36	FEED DRIVING GEAR	1
13	K-B36-1	KEY 3x3x8L	1
14	K-B15	FEED REVERSE BEVEL GEAR	1
15	K-B13	WASHER Ø 6, 22 OD	1
16	K-B14	SOC HD SCREW M6-P1.0x15L	1
17	K-B37	KEY 3x3x10L	1
18	K-B40	FEED DRIVE GEAR	1
19	K-B16	FEED ENGAGE PIN	1
20	K-B06	SETSCREW M6-P1.0x6L	1

i00700-K2-K3

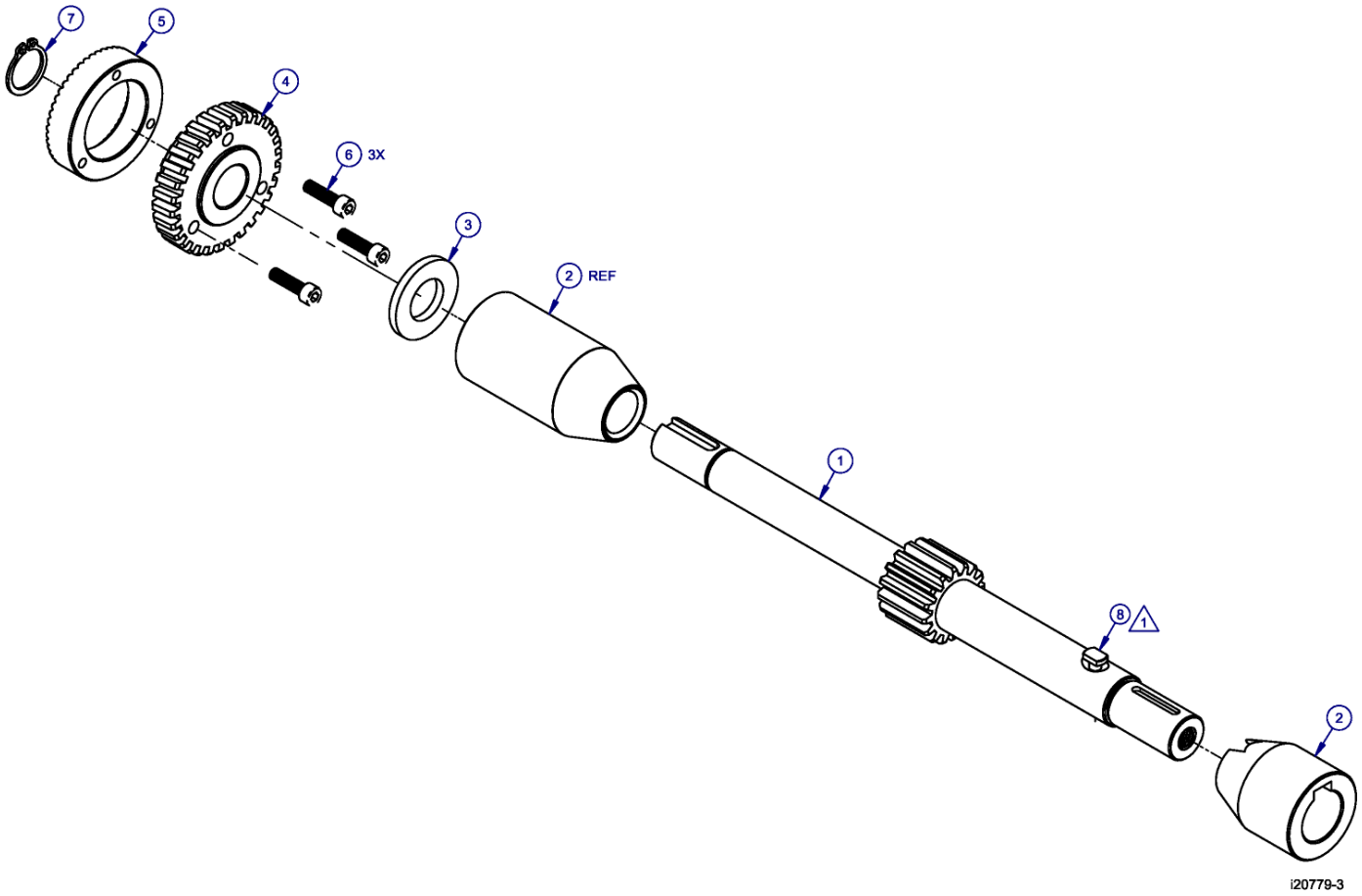
Figure 128
Worm Gear Cradle
P/N: 20779-1



Item	P/N	Title	Qty
1	K-B66	CLUSTER GEAR COVER	1
2	K-B64	CLUSTER GEAR SHAFT CRANK	1
3	K-B70	SHIFT CRANK	1
4	K-B69	SPRING Ø 3 x 20L	1
5	K-B68	GEAR SHIFT PLUNGER	1
6	K-B72	SHIFT KNOB-5/16-18NC	1
7	K-B71	ROLL PIN Ø 3 x 20L	1
8	K-B63	FEED GEAR SHIFT FORK	1
9	K-B65	SHAFT	1
10	K-B61	CAP SET SCREW M5-P0.8x5L	1

i00701-K2-K3

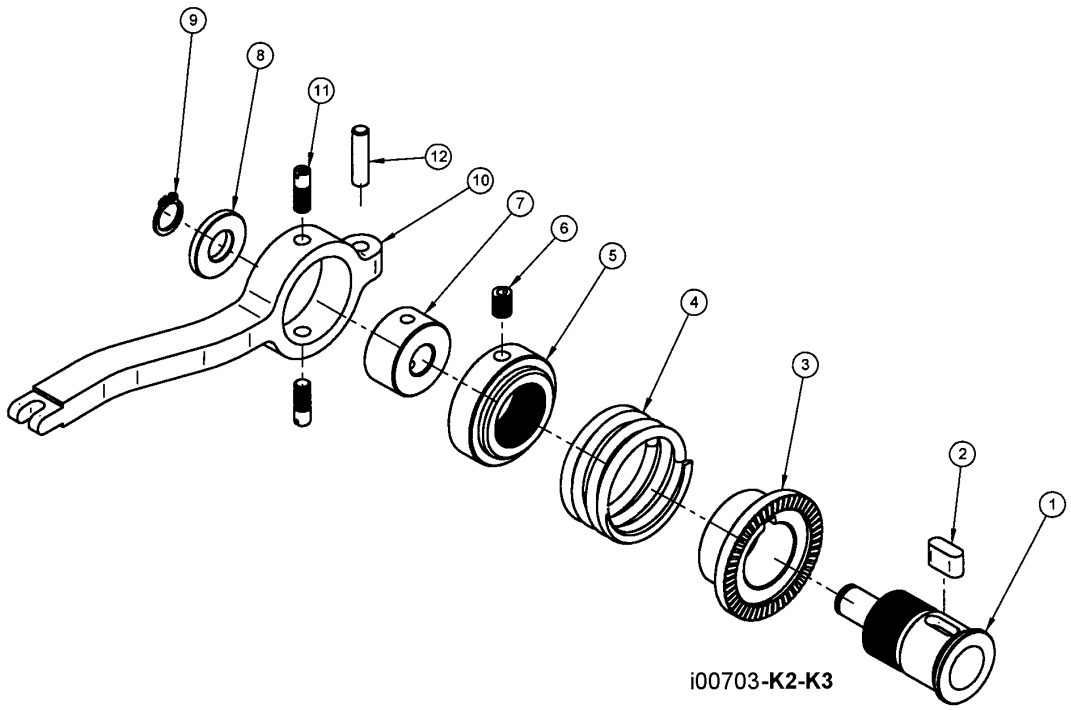
Figure 129
Quill Feed Selector
P/N: 20779-2



Item	P/N	Title	UseAs	Qty
1	K-B166	QUILL PINION SHAFT	EA	1
2	25706	BUSHING KIT-PINION SHAFT-R8	EA	1
3	K-B91	WASHER	EA	1
4	K-B92	OVERLOAD CLUTCH WORM GEAR	EA	1
5	K-B93	OVERLOAD CLUTCH RING	EA	1
6	K-B92-1	SCREW SOC HD CAP M4-P0.7x15L	EA	3
7	K-B94	SNAP RING 95 DOWEL PIN Ø 14	EA	1
8	K-B168	SCREW PIN	EA	(1)

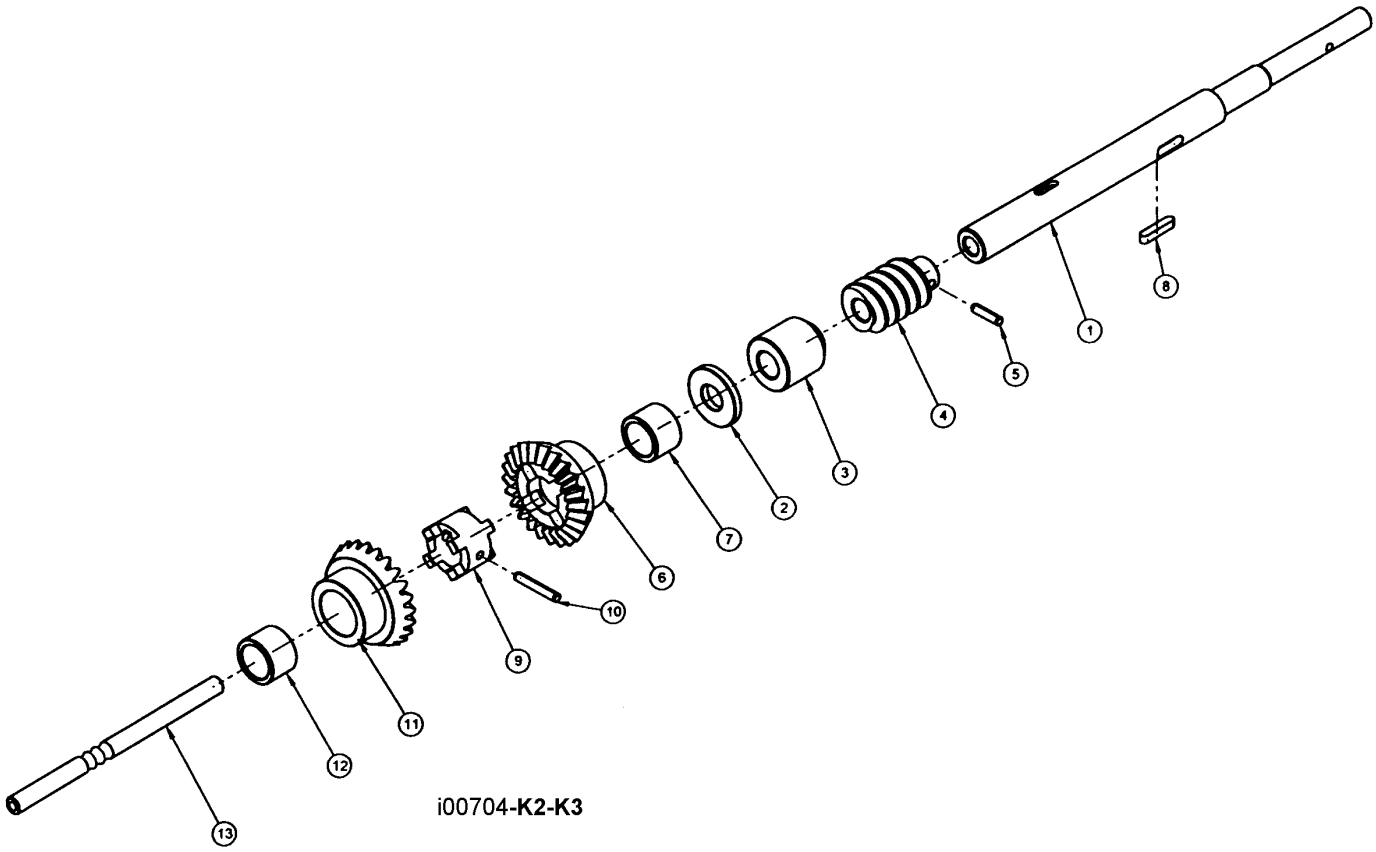
i20779-3

Figure 130
Quill Pinion Shaft
P/N: 20779-3



Item	P/N	Title	Qty
1	K-B81	OVERLOAD CLUTCH SLEEVE	1
2	K-B81-1	KEY 5x8x13L	1
3	K-B80	OVERLOAD CLUTCH	1
4	K-B79	SAFETY CLUTCH SPRING	1
5	K-B78	OVERLOAD CLUTCH LOCKNUT	1
6	K-B76	SOCKET SET SCREW M6-P1.0x8L	1
7	K-B75	CLUTCH RING	1
8	K-B97	OVERLOAD CLUTCH WASHER	1
9	K-B98	SNAP RING Ø 10	1
10	K-B96	OVERLOAD CLUTCH TRIP LEVER	1
11	K-B74	CLUTCH RING PIN (2REQ.)	2
12	K-B77	BRASS PLUG	1
		i00703-K2-K3	

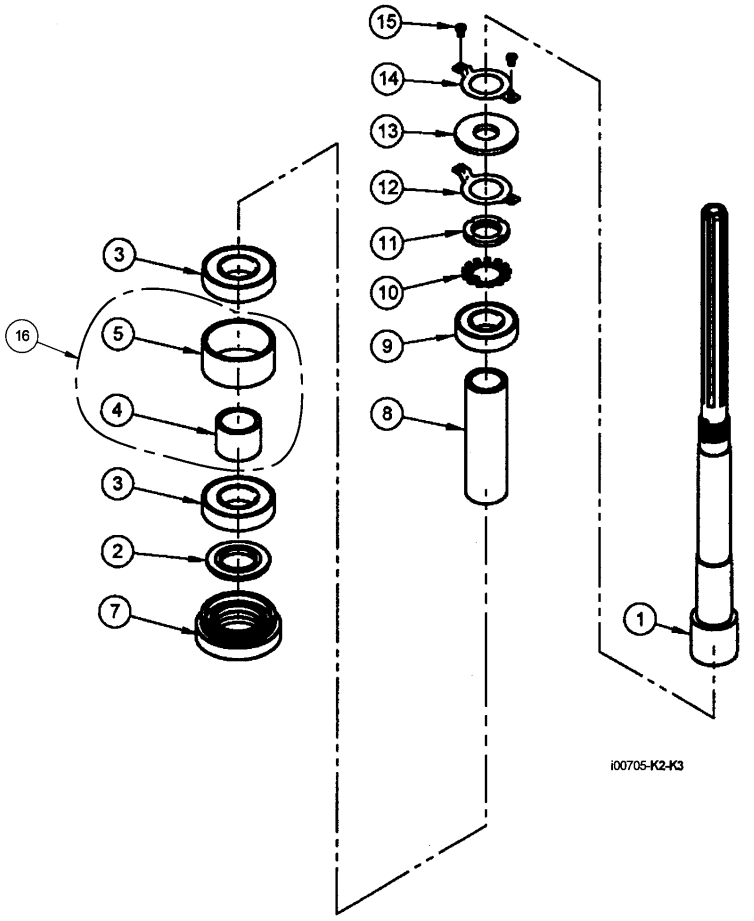
Figure 131
Overload Clutch Trip
P/N: 20779-4



Item	P/N	Title	Qty
1	K-B57	FEED WORM SHAFT	1
2	K-B47	FEED WORM SHAFT THRUST WASHER	1
3	K-B44	FEED WORM SHAFT BUSHING	1
4	K-B43	WORM	1
5	K-B59	PIN Ø 3x12L	1
6	K-B49	FEED REVERSE BEVEL GEAR	1
7	K-B48	BUSHING	1
8	K-B62	KEY 3x3x15L	1
9	K-B50	FEED REVERSE CLUTCH	1
10	K-B56	PIN Ø 3x19L	1
11	K-B51	FEED REVERSE BEVEL GEAR	1
12	K-B52	BUSHING	1
13	K-B55	REVERSE CLUTCH ROD	1

i00704-K2-K3

Figure 132
Feed Reverse Clutch
P/N: 20779-5



Item	P/N	DESCRIPTION	Qty
1	K-B127	SPINDLE R8	1
2	K-B134	SPINDLE DIRT SHIELD	1
3	20838	BEARING 7207CTYNSULP4	1 SET
4	K-B136	BEARING SPACER-SMALL	1
5	K-B137	BEARING SPACER-LARGE	1
7	K-B133	NOSE-PIECE	1
8	K-B132	SLEEVE	1
9	K-B131	BEARING-6206ZZ	1
10	K-B130	BEARING LOCKWASHERØ 30	1
11	K-B129	SPINDLE BEARING LOCK NUT- Ø30-20N	1
12	K-B150-1	STRAIGHT LOWER CLAMP	1
13	K-B151	FELT OIL STRAINER	1
14	K-B150-2	STRAINER UPPER CLAMP	1
15	K-B139	SCREW-PH-HD-M5-0.8X8L	2
16	20840	BEARING SPACER SET	1

i00705-K2-K3

Figure 133
Spindle Assembly
P/N: 20836

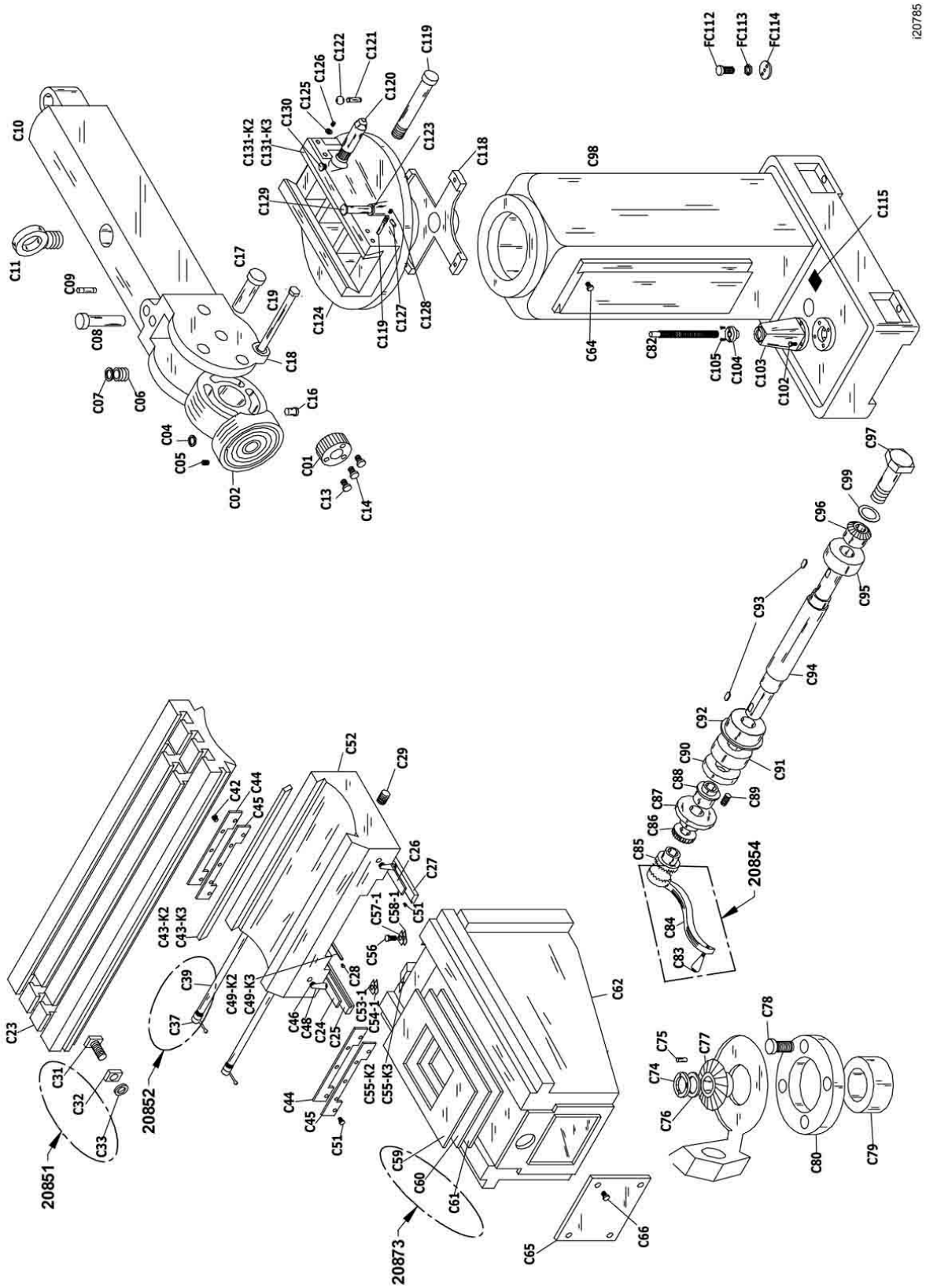


Figure 134
K2/K3 Base Machine P/N 20785
Parts List – K2 & K3 Base Machine (reference only)

Item	P/N	Title	Comments
1	C01	QUILL HOUSING ADJ.GEAR	
2	C02	RAM ADAPTER	
3	C04	NUT	
4	C06	VERTICAL ADJUSTING WORM	
5	C07	WORM THRUST WASHER(2REQ.)	
6	C08	VERTICAL ADJUSTING WORM SHAFT	
7	C09	WORM KEY	
8	C10	RAM	
9	C13	SOCKET CAP SCREW(2REQ.)	
10	C14	ROLL DOWEL PIN	
11	C15	ANGLE PLATE	
12	C16	ROUND HD DRIVE SCREW(5REQ.)	
13	C17	ADAPTER PIVOT PIN	
14	C18	CHAMFERED & HARDENED WASHER(7REQ.)	
15	C19	ADAPTER LOCKING BOLT(3REQ.)	
16	C23	TABLE 42" OR 48"	
17	C31	STOP PIECE T-BOLT(3REQ.)	Available only in 20851
18	C32	TABLE STOP PIECE(2REQ.)	Available only in 20851
19	C33	HEX NUT(3REQ.)	Available only in 20851
20	C37	TABLE LOCK BOLT HANDLE	Available only in 20852
21	C38	SADDLE LOCK BOLT	
22	C39	SADDLE LOCK PLUNGER	Available only in 20852
23	C40	SOCKET HD CAP SCREW(2REQ.)	
24	C41	GIB ADJUSTING SCREW(3REQ.)	
25	C42	TABLE STOP BRACKET (not shown on drawing)	
26	C43-K2 C43-K3	SADDLE/TABLE GIB	
27	C44	FELT WIPERS(4REQ.)	
28	C46	TABLE LOCK PLUNGER	
29	C47	TABLE LOCK BOLT	
30	C48	TABLE LOCK BOLT HANDLE	
31	C49-K2 C49-K3	SADDLE/KNEE GIB	
32	C50	SADDLE KNEE WIPER PLATE(4REQ.)	
33	C51	OVAL HEAD SCREW(8REQ.)	
34	C53-1	LEFT HAND COLUMN WIPER HOLDER	
35	C52	SADDLE	
36	C54-1	KNEE WIPER FELT	
37	C55-K2 C55-K3	KNEE/COLUMN GIB	
38	C56	ALLEN CAP SCREW(2REQ.)	
39	C57-1	RIGHT HAND COLUMN WIPER HOLDER	
40	C58-1	KNEE WIPER FELT	
41	C59	CHIP GUARDS-UPPER	Available only in 20873
42	C60	CHIP GUARDS-MIDDLE	Available only in 20873
43	C61	CHIP GUARDS-LOWER	Available only in 20873
44	C62	KNEE	
45	C64	STOP SCREW	

46	C65	KNEE LOCK SHAFT ASSEMBLY	
47	C69	KNEE LOCK PLUNGER	
48	C71	KNEE BINDER PLUG(PLASTIC)	
49	C72	DOG POINT SET SCREW	
50	C73	SET SCREW	
51	C74	JAM NUT	
52	C75	KEY	
53	C76	WASHER	
54	C77	BEVEL GEAR	
55	C79	SEALED BALL BEARING	
56	C80	BEARING RETAINER RING	
57	C81	SOCKET HEAD CAP SCREW	
58	C82	ELEVATING SCREW ASSEMBLY	Available only in 20854
59	C83	HANDLE	Available only in 20854
60	C84	ELEVATING CRANK	
61	C85	GEARSHAFT CLUTCH INSERT	
62	C86	DIAL LOCK NUT	
63	C87	DIAL WITH 100 GRADUATIONS	
64	C88	DIAL HOLDER	
65	C89	SOCKET HEAD CAP SCREW	
66	C90	BEARING RETAINING RING	
67	C91	GREASE SEALED BEARING	
68	C92	BEARING CAP	
69	C93	KEY	
70	C94	ELEVATING SHAFT FOR 12" KNEE	
71	C95	GREASE SEALED BEARING	
72	C96	BEVEL PINION	
73	C97	SET SCREW	
74	C98	COLUMN	
75	C99	WASHER	
76	C102	SOCKET HEAD CAP SCREW	
77	C103	PEDESTAL	
78	C104	ELEVATING SCREW NUT	
79	C105	SOCKET HEAD CAP SCREW	
80	C118	SPIDER	
81	C119	RAM LOCK STUD	
82	C120	RAM PINION	
83	C121	RAM PINION HANDLE	
84	C122	PLASTIC BALL	
85	C123	CHAMFERED HARDENED WASHER	
86	C124	TURRET	
87	C125	GIB SCREW NUT	
88	C126	GIB SCREW	
89	C127	LOCK BAR	
90	C128	SCREW	
91	C129	LOCKING BOLT	
92	C130	RAM PINION SCREW	
93	C131-K2 C131-K3	RAM/TURRET GIB	

94	20851	STOP PIECE T-BOLT ASSY	
95	20852	TABLE LOCK HANDLE	
96	20853	KNEE LOCK HANDLE & SHAFT	
97	20854	KNEE CRANK HANDLE ASSY	
98	20873	CHIP GUARD SET K2/K3	
99	FC112	LEVELING SCREW	
100	FC113	LEVELING NUT	
101	FC114	LEVELING PAD	

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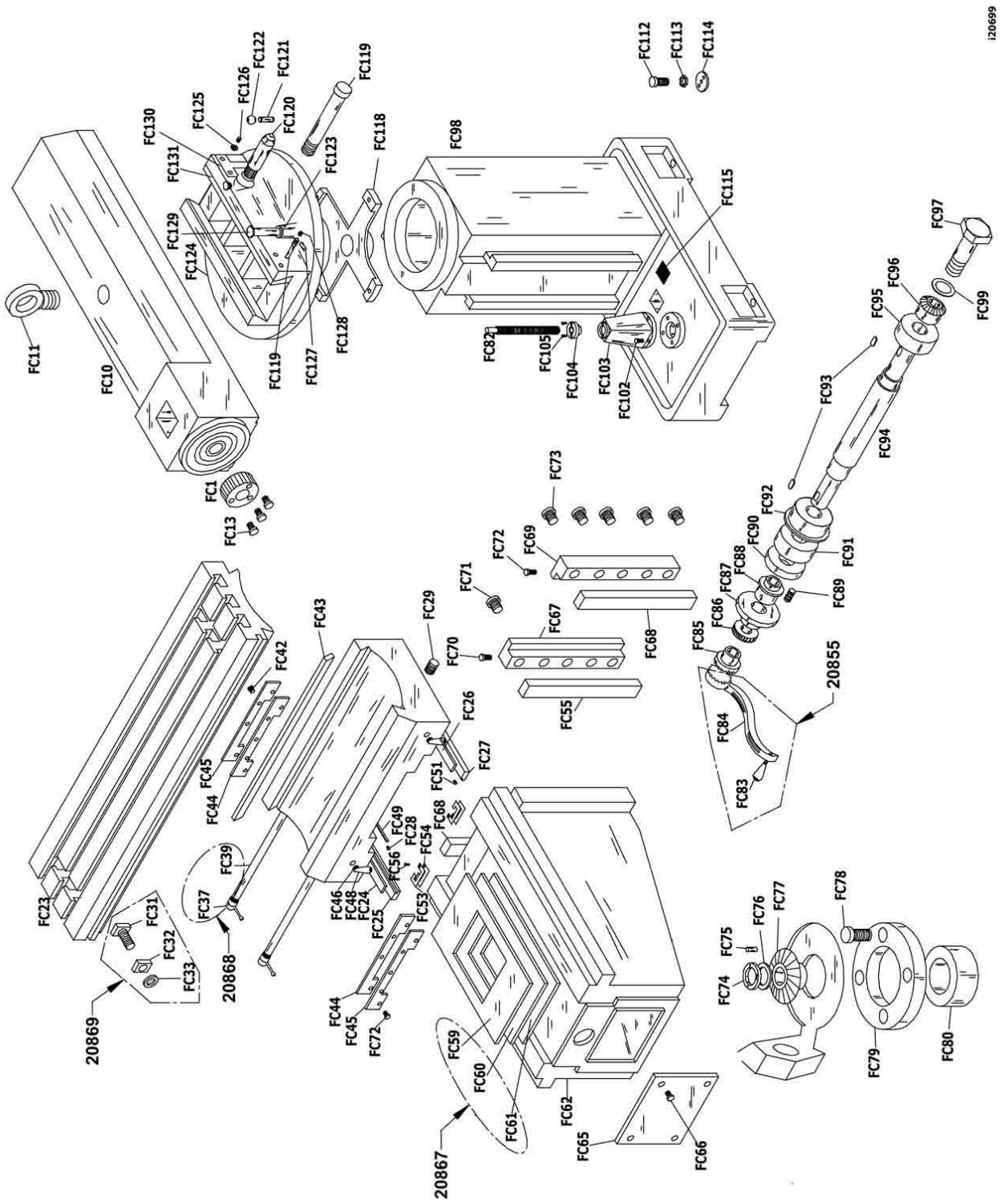

Figure 135
K4 Base Machine P/N 26900

Parts List - K4 Base Machine

Item	P/N	Title	Comments
1	FC1	QUILL HOUSING GEAR	
2	FC10	RAM	
3	FC11	LIFTING EYE BOLT	
4	FC23	TABLE 50"	
5	FC24	SADDLE BOTTOM GIB	
6	FC25	GIB BLOCK	
7	FC26	GIB	
8	FC27	GIB BLOCK	
9	FC28	SET SCREW	
10	FC29	SET SCREW	
11	FC31	STOP PIECE T-BOLT	Available only in 20869
12	FC32	TABLE STOP PIECE	Available only in 20869
13	FC33	HEX NUT	Available only in 20869
14	FC37	TABLE LOCK HANDLE	Available only in 20868
15	FC39	SADDLE LOCK PLUNGER	Available only in 20868
16	FC42	TABLE STOP BRACKET (not shown on dwg)	
17	FC43	SADDLE/TABLE GIB	
18	FC44	SADDLE CHIP WIPER	
19	FC45	SADDLE CHIP WIPER PLATE	
20	FC46	TABLE LOCK PLUNGER	
21	FC48	TABLE LOCK BOLT HANDLE	
22	FC49	SADDLE GIB	
23	FC51	CAP SCREW	
24	FC52	SADDLE	
25	FC53	LEFT HAND COLUMN WIPER HOLDER	
26	FC54	KNEE WIPER FELT	
27	FC55	KNEE/COLUMN GIB	
28	FC56	ALLEN CAP SCREW	
29	FC57	RIGHT HAN COLUMN WIPER HOLDER	
30	FC58	KNEE WIPER FELT	
31	FC59	CHIP GUARDS - UPPER	Available only in 20867
32	FC60	CHIP GUARDS - MIDDLE	Available only in 20867
33	FC61	CHIP GUARD LOWER	Available only in 20867
34	FC62	KNEE	
35	FC65	KNEE PLATE	
36	FC66	CAP SCREW	
37	FC67	GIB BLOCK	
38	FC68	KNEE GIB	
39	FC69	GIB BLOCK	
40	FC70	CAP SCREW	
41	FC71	CAP SCREW	
42	FC72	CAP SCREW	
43	FC73	CAP SCREW	
44	FC74	JAM NUT	
45	FC75	KEY	
46	FC76	WASHER	
47	FC77	BEVEL GEAR	

48	FC78	SCREW	
49	FC79	SEALED BALL BEARING	
50	FC80	BEARING RETAINER RING	
51	FC82	ELEVATING SCREW ASSY	
52	FC83	HANDLE	Available only in 20855
53	FC85	GEARSHAFT CLUTCH INSERT	
54	FC86	DIAL LOCK NUT	
55	FC87	DIAL WITH GRADUATIONS	
56	FC88	DIAL HOLDER	
57	FC89	SOCKET HEAD CAP SCREW	
58	FC90	BEARING RETAINING RING	
59	FC91	GREASE SEALED BEARING	
60	FC92	BEARING CAP	
61	FC93	KEY	
62	FC94	ELAVATING SHAFT	
63	FC95	GREASE SEALED BEARING	
64	FC96	BEVEL PINION	
65	FC97	SET SCREW	
66	FC98	COLUMN & BASE- K4	
67	FC102	SOCKET HEAD CAP SCREW	
68	FC103	PEDESTAL	
69	FC104	ELEVATING SCREW NUT	
70	FC105	SOCKET HEAD CAP SCREW	
71	FC112	CAP SCREW	
72	FC113	NUT	
73	FC114	MACHINE MAT	
74	FC115	OIL FILTER	
75	FC118	SPIDER	
76	FC119	RAM LOCK STUD	
77	FC120	RAM PINION	
78	FC121	RAM PINION HANDLE	
79	FC122	PLASTIC BALL	
80	FC123	CHABERED HARDENED WASHER	
81	FC124	TURRET	
82	FC125	GIB SCREW NUT	
83	FC126	GIB SCREW	
84	FC127	LOCK BAR	
85	FC128	SCREW	
86	FC129	LOCKING BOLT	
87	FC130	RAM PINION SCREW	
88	FC131	RAM/TURRET GIB	
89	20855	FRU-SK4-KNEE CRANK HANDLE ASSY	
90	20867	FRU-SK4-CHIP COVER ASSY	
91	20868	FRU-SK4-HANDLE & BAR LOCK ASSY	
92	20869	FRU-SK4 FC31,FC32,FC333	

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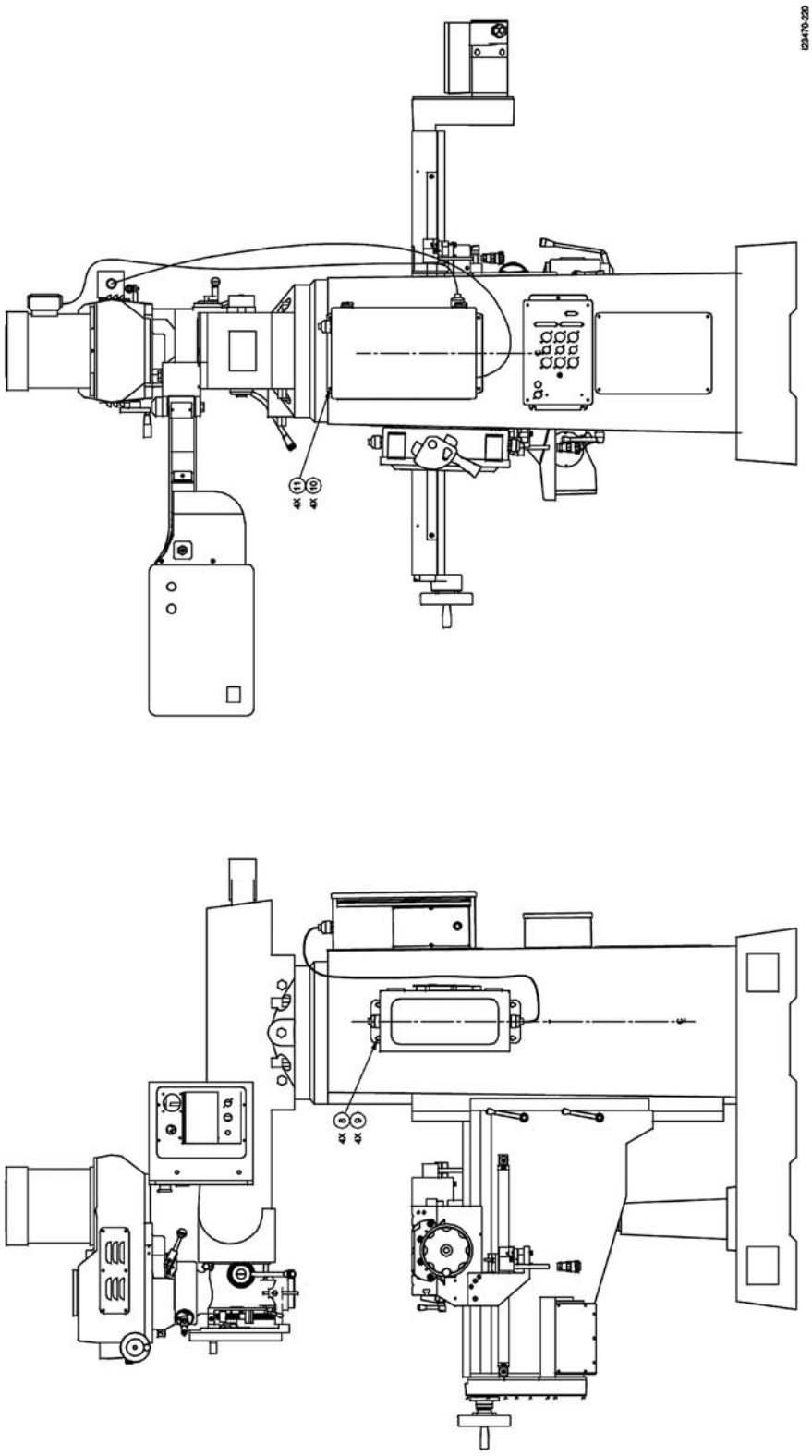

Figure 136
Transformer Option 220V &440V
P/N: 23470-220 or 23470-440

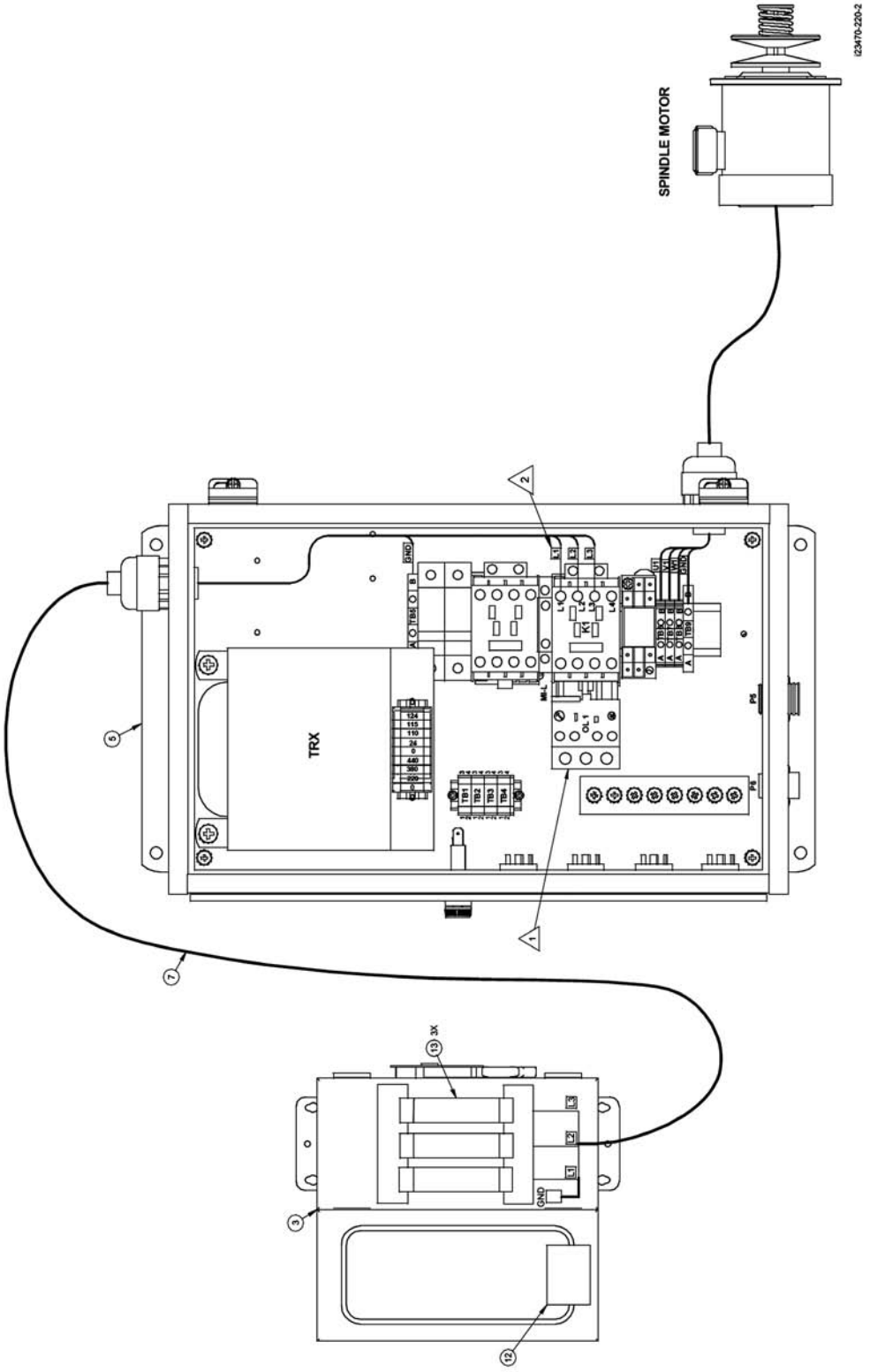

Figure 137
Transformer Options 220V & 440V
P/N 23470-220 or 23470-440

Transformer Options Part List
P/N 23470-220 & 23470-440

Item	P/N	Title
3	23430-M0D	SAFETY SWITCH - 30A - 600VAC - MODIFIED
5	23440-220	ENCLOSURE ASSY-TRANSFORMER OPTION-220V
5	23440-440	ENCLOSURE ASSY-TRANSFORMER OPTION-440V
7	23454-3	CABLE ASSY-SAFETY SWITCH/XFMR MODULE-DPM
12	24927-10	LABEL-FUSE CHART REPLACEMENT-220V
12	24927-5	LABEL-FUSE CHART REPLACEMENT-440V
13	24910-15	FUSE-TIME DELAY-15 AMPS-220V
13	24910-10	FUSE-TIME DELAY-10 AMPS-440V

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Southwestern Industries, Inc

TRAK Warranty Policy

Warranty

TRAK products are warranted to the original purchaser to be free from defects in work-manship and materials for the following periods:

Product	Warranty Period	
	Materials	Factory Labor
New TRAK	1 Year	1 Year
Any EXCHANGE Unit	90 Days	90 Days

The warranty period starts on the date of the invoice to the original purchaser from Southwestern Industries, Inc. (SWI) or their authorized distributor.

If a unit under warranty fails, it will be repaired or exchanged at our option for a properly functioning unit in similar or better condition. Such repairs or exchanges will be made FOB Factory/Los Angeles or the location of our nearest factory representative or authorized distributor.

Disclaimers of Warranties

- This warranty is expressly in lieu of any other warranties, express or implied, including any implied warranty of merchantability or fitness for a particular purpose, and of any other obligations or liability on the part of SWI (or any producing entity, if different).
- Warranty repairs/exchanges do not cover incidental costs such as installation, labor, freight, etc.
- SWI is not responsible for consequential damages from use or misuse of any of its products.
- TRAK products are precision mechanical/electromechanical measurement systems and must be given the reasonable care that these types of instruments require:
- Replacement of chip scrapers and wipers is the responsibility of the customer. Consequently, the warranty does not apply if chips have been allowed to enter the mechanism.
- Accidental damage, beyond the control of SWI, is not covered by the warranty. Thus, the warranty does not apply if an instrument has been abused, dropped, hit, disassembled or opened.
- Improper installation by or at the direction of the customer in such a way that the product consequently fails, is considered to be beyond the control of the manufacturer and outside the scope of the warranty.